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ABSTRACT

The course is intended to help meet, in a relatively short time, the need for trained operators in metalworking. It can be used by students with little education or experience and is suitable for use in adult education programs and in manpower development and training programs. The course is designed to be completed in approximately 30 weeks and can be adapted for use in secondary schools. On successful completion of the course the student will be qualified for an entry-level job as operator in a drill press; he will not qualify as a machinist. The guide includes a general job content outline for the teacher to use in explaining what the operator's job includes. There are 11 shop projects (comprising 19 jobs) accompanied by 32 pages of drawings for the projects. Three of the jobs introduce students to the use of metric measurement. For each job there is a job sheet providing details on performance objectives, equipment, operations, materials, references, procedure, techniques, and time required. (Author/PR)

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Machine Industries Occupations

INSTRUCTOR'S GUIDE FOR AN ADULT COURSE

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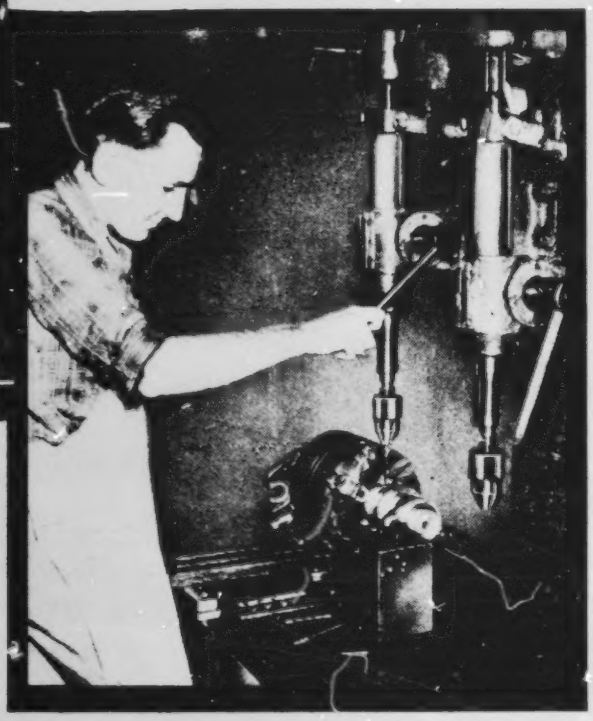

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DRILL PRESS OPERATOR

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Drill Press Operator

INSTRUCTOR'S GUIDE

Part of
SINGLE-TOOL SKILLS PROGRAM
MACHINE INDUSTRIES OCCUPATIONS

The University of the State of New York
THE STATE EDUCATION DEPARTMENT
Bureau of Continuing Education Curriculum Development
Bureau of Secondary Curriculum Development
Albany, New York 12234
1975

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Foreword

The *Drill Press Operator* course contained in this book is intended to help fill the need for people trained to operate machine tools. The backgrounds of those who enter the course will cover a broad range of qualifications, but it is likely that many people with little education or experience will be included. Completion of this course alone, obviously will not make anyone a full-fledged machinist.

This course is the fourth one to be published in a series of instructor's guides for the Single-Tool Skills Program. (*Engine Lathe Operator* was published in 1972, *Surface Grinder Operator* in 1973, and *Milling Machine Operator* in 1974.) Although written primarily as an adult course, the secondary level teacher can use the content of this book in a course he or she might develop for the students. *Drill Press Operator* was produced as a joint project of the two curriculum bureaus named on the title page.

The Single-Tool Skills Program is one of the programs in a broad plan covering machine industries occupations. The original plan was conceived by Robert S. Hunter, former associate in the Bureau of Trade and Technical Education. A number of teachers were involved in the overall planning for machine industries occupations and also wrote material for the course guides. They are Elek D. Csont, Seneca Vocational High School, Buffalo; Jack Grossman, Alexander Hamilton High School, Brooklyn; Alfred Kagan, Sewanhaka High School, Floral Park; Gilbert Pultz, Jefferson Vocational and Technical Center, Watertown; William G. Stewart, North Senior High School, Binghamton; William F. Tiedemann, Central Technical High School, Syracuse; and Joseph Waldinsperger, College of Continuing Education, Rochester Institute of Technology, Rochester.

Other members of the State Education Department took part in the overall planning and in the further detailed planning which resulted in the production of this publication. They are E. Noah Gould, associate in the Bureau of Continuing Curriculum; G. Earl Hay, supervisor in the Bureau of Secondary Curriculum; Edward Shattuck, former associate in the Bureau of Trade and Technical Education; and Charles A. Stebbins, associate in the last-named bureau.

Messrs. Kagan, Stewart, and Tiedemann wrote the *Drill Press Operator* course contained in this book. Most of the drawings in this guide are taken from previous publications in the series. The additional drawings needed and changes in old drawings were made by Eugene F. Stalica, Jr., professor at Hudson Valley Community College, Troy. Mr. Gould, who is in general charge of the Single-Tool Skills series, directly supervised the writing and edited the manuscript.

HERBERT BOTHAMLEY, *Chief*
Bureau of Continuing Education
Curriculum Development

GORDON E. VAN HOOFT, *Director*
Division of Curriculum Development

Message to the Instructor

This *Drill Press Operator* course is expected to help meet the need for trained operators in metalworking. The course is suitable for use in the adult education programs of school districts,and in Manpower Development and Training programs. It can also be adapted for use in secondary schools.

Anyone who completes this course successfully will be qualified for an entry-level job as operator of a drill press. Some students may also complete other single-tool courses and qualify to operate more than one machine tool. It is even possible that a student with outstanding ability, by completing the courses for several machine tools, could become a machinist.

The 11 projects in this course (which include 19 shop jobs) are listed on the page after *Contents*. There is no requirement that any student complete all projects, or even all jobs within any project. The instructor may determine which projects and jobs a given student should complete and whether to have him use conventional or metric dimensions. The instructor may also use other jobs not included in this book.

The teacher for this course would ideally be a person with not only good training and experience in machinist skills, but also several years of teaching experience. The best sources from which to draw teachers are the faculties of schools giving machine tool courses and the ranks of those employed as machinists and supervisors of machinists.

An administrator or instructor who has any questions or comments about this publication should direct them to either the Bureau of Trade and Technical Education or to one of the bureaus named on the title page.

CARL G. BENENATI, *Chief*
Bureau of Trade and Technical Education

ROBERT H. BIELEFELD, *Director*
Division of Occupational Education Instruction

Contents

	Page
Foreword	iii
Message to the Instructor	iv
List of Shop Projects	vi
List of Drawings for Shop Projects	vii
INTRODUCTION	1
GENERAL JOB CONTENT	5
JOB SHEETS FOR SHOP PROJECTS	10
BIBLIOGRAPHY	43
DRAWINGS FOR SHOP PROJECTS	44

MACHINE INDUSTRIES OCCUPATIONS
SINGLE-TOOL SKILLS PROGRAM
DRILL PRESS OPERATOR COURSE

LIST OF SHOP PROJECTS

Project No.		Time (hrs.)	Page
I.	Drill Stand		
	Job 1. Drill Stand	9	11
II.	Parallel Clamp		13
	Job 1A. Loose Jaw (inches)	4	
	Job 1B. Loose Jaw (millimeters)	4	
	Job 2. Threaded Jaw (inches)	3	
III.	Parallels		19
	Job 1A. Parallels (inches)	6	
	Job 1B. Parallels (millimeters)	6	
IV.	Bench Vise		23
	Job 1. Screw	$1\frac{1}{2}$	
	Job 2. Fixed and Movable Jaws	3	
V.	Arbor Press		27
	Job 1. Base	3	
VI.	Tap Wrench		29
	Job 1. Tap Wrench Body	$1\frac{1}{2}$	
VII.	1-2-3 Block		30
	Job 1. 1-2-3 Block (Dual Dimensioning)	5	
VIII.	Micrometer Boring Head		32
	Job 1. Dovetail Blocks	$2\frac{1}{2}$	
IX.	Precision Step Block		34
	Job 1. Precision Step Block	$2\frac{1}{2}$	
X.	Motor Plate		36
	Job 1. A, B, and C Holes	2	
	Job 2. D Holes	$1\frac{1}{2}$	
	Job 3. E Holes	2	
	Job 4. F and G Holes	3	
	Job 5. H Hole	2	
XI.	Close Quarters Hacksaw		42
	Job 1. Adjustable Blade Retainer	$\frac{1}{2}$	

MACHINE INDUSTRIES OCCUPATIONS
SINGLE-TOOL SKILLS PROGRAM
DRILL PRESS OPERATOR COURSE

LIST OF DRAWINGS FOR SHOP PROJECTS

Dwg. No.	Title of Drawing	Project	Drill Press Jobs Covered	Page
13	Close Quarters Hacksaw: Assembly	XI	1	45
14	Close Quarters Hacksaw: Details		1	46
15	Bench Vise Assembly	IV	1,2	47
16	Bench Vise Details		1	48
17	Bench Vise: Fixed and Movable Jaws		2	49
21	Tap Wrench	VI	1	50
22	Micrometer Boring Head: Assembly	VIII	1	51
22.1	Micrometer Boring Head: Plate		None	52
22.2	Micrometer Boring Head: Dovetail Blocks		1	53
23	Micrometer Boring Head: Dial, Shank, and Stop Pin		None	54
24	Micrometer Boring Head: Dovetail Slide		None	55
27	Arbor Press: Assembly	V	1	56
28	Arbor Press: Gear Shaft, Rack Pad, and Rack		None	57
29	Arbor Press: Table		None	58
30	Arbor Press: Sleeve, Table Pin, and Cover Plate		None	59
31	Arbor Press: Handle and End		None	60
32	Arbor Press: Column		None	61
33	Arbor Press: Base		1	62
42	Drill Stand	I	1	63
44	Precision Step Block	IX	1	64
45.1	1-2-3 Block (Dual Dimensioning)	VII	1	65
50A	Parallels (Inches)	III	1A	66
50B	Parallels (Millimeters)		1B	67
56	Parallel Clamp: Assembly	II	1A,1B,2	68
57A	Parallel Clamp: Loose Jaw (Inches)		1A	69
57B	Parallel Clamp: Loose Jaw (Millimeters)		1B	70
58A	Parallel Clamp: Threaded Jaw (Inches)		2	71
58B	Parallel Clamp: Threaded Jaw (Millimeters)		None	72
59	Parallel Clamp: Straight Clip		None	73
60	Parallel Clamp: Clamping Screw		None	74
61	Parallel Clamp: Adjusting Screw		None	75
72	Motor Plate	X	1,2,3,4,5	76

Introduction

As shown in the contents, this *Drill Press Operator* course consists of this Introduction, General Job Content (which explains what the operator's job includes), Job Sheets for projects, and the drawings for the projects. The course covers the operation of the drill press only.

Objectives of the Course

The job for which the trainee would be qualified upon completion of this course is referred to in the Dictionary of Occupational Titles (under the code number 606.380) as drill press operator; drill press operator, multiple spindle; drill press operator, radial; gang drill press operator. Other job titles are also used under this and other code numbers.

The general objective of the course is to train persons, in a relatively short time, to be placed as drill press operators. Another important purpose is to help those with very little background. The course is not intended to give a broad training in metalworking, but only the skill to operate one kind of metalworking machine. By keeping the objective narrow, the training time is kept to a minimum, and the trainees are made available for work without a long delay.

Units of Measurement

Generally speaking, conventional units of measurement (inches for linear dimensions, and degrees for angles) are used in this course. However, an attempt has been made to introduce the students to metric measurement by using millimeters for dimensions in several projects, in addition to the conventional units.

The United States is the only big country in the world which is not either using metric measurements or in a program for changing to metrics. Legislation is now pending in Congress which is likely to start us on a 10-year changeover period which would result in making metric units the predominant means of measurement. The much greater convenience of metric units and our increasing trade with countries on the metric system are the main forces pushing us toward metrication.

In American industry, some companies are already using metric measurements to a large extent in their products. Examples of such companies are the Beloit Tool Corporation of South Beloit, Illinois, and the Caterpillar Tractor Company of Peoria, Illinois. American metalworking companies using metric units are apparently continuing to use conventional thread

systems. This is because, according to some authorities, the conventional threads have some significant advantages over metric threads. References listed in the bibliography contain further information on metrics.

Metric Units in this Course

In this course, the workpieces for three shop jobs have been designed in both conventional and metric units. Job Sheets and drawings using both inches and millimeters are included so an instructor can have a student make these pieces in either conventional or metric dimensions or both. These jobs are:

Project	Job	
II	1A & 1B	Parallel Clamp Loose Jaw
II	2A & 2B	Parallel Clamp Threaded Jaw
III	1A & 1B	Parallels

In Projects II and III, Job 1A is in conventional units and Job 1B is in metric units. For these jobs, the only additional instruments suggested are a 15 cm. metric scale, a 0-25 mm. micrometer, and a metric dial indicator.

Drawings and Job Sheets

The drawings in this course are part of a serially numbered set beginning with No. 1, which appears in the *Engine Lathe Operator* course. The numbers continue through the drawings of other courses in the Single-Tool Skills Series including this one. They will be continued further in any other courses in the series which might be published later. Drawings in this course which are also in one of the other courses are reproduced here with the same drawing numbers. Some drawings appear in this book which are not needed for the shop projects of this course. They are included here for the convenience of keeping together all the drawings of an assembly. Those in this publication run from 13 through 62 of the series.

In the drawings, all dimensions are in inches unless otherwise indicated. A number of drawings contain tables giving several different sets of dimensions for the workpieces pictured. These tables permit the instructor to select the set of dimensions which he finds best for each student or for the conditions under which his class operates.

Each job sheet has the words *Unit No.* in the upper left corner, but no number is given. The instructor may wish to write a number in this space to fit in with his own method of organizing his classroom and shop work.

Assignment of Work to Students

As a shop project is assigned to a student, we recommend that the instructor give him copies of the applicable Job Sheets and drawings. The binding of this book permits easy removal of pages for copying. When copies are made the pages themselves must be kept clean and should not be used by

anyone working on a machine. After any copies are made the pages should be replaced in the book and the book should be kept in a looseleaf cover.

Each drawing has four blocks for information at the bottom and two of them are blank. We suggest that the instructor have the student write the numbers of the project and job for which he is using the drawing in one of these blank spaces on his own copy.

Many of the workpieces on which drilling is to be done in this course are those produced in other courses in the Single-Tool Skills series. If a given workpiece is not available as the output of another course in his shop, it is the instructor's responsibility to obtain the workpiece. In some cases, he may need to make it himself.

Administration of the Course

We believe that enough general information about the job and more than enough shop projects are included for the trainee to reach the general objective of the course. All essential drill press skills are used in the shop jobs a number of times.

The schools may use everything in the course, they may select only some of the material, they may make changes in it, and they may use other material not contained here. They may also determine the length of the class periods, their frequency, and the total amount of time to be spent in training. For those that need a guide: A typical adult night class runs $2\frac{1}{2}$ to 3 hours, either once or twice a week, for 30 weeks.

The prerequisites for admission to an adult course should be broad enough so none will be barred who could be made employable. The operating authorities for each program, school, and school district have the responsibility for determining the prerequisites for such a course, and can adapt them to any special local conditions.

The *minimum* prerequisites we suggest for a trainee (and they are not mandatory) are that he have enough ability to understand and follow the course instructions (both written and oral) so he can produce the simplest workpiece included in the course. Such a trainee will, perhaps, be able to qualify only as a production machine operator, where all the machine setups are made for him. Another trainee with more background will possibly qualify for jobs requiring more skill, such as drill press setup man.

The Job Sheets show two references which are especially recommended for drill press work. The bibliography gives the complete citations for these two books and also contains additional references.

Abbreviations used in this course are given on the next page.

Abbreviations Used in Text and Drawings

ALUM.	aluminum
ASSY.	assembly
CHAM.	chamfer
CBORE.	counterbore
CM.	centimeter(s)
CRS	cold rolled steel
CSK.	countersink
DIA.	diameter
DP.	deep
DP	diametral pitch
DR.	drill
DR or DR. ROD	drill rod
EQ. SP.	equally spaced
FAO	finish all over
HD	head
HDL.	handle
HGT.	height
HEX.	hexagonal
H.S.	high-speed
HT.	height
LG.	long
LGTH.	length
MATL.	material
MED.	medium
MM.	millimeters
PT.	part
R or RAD.	radius
REQD.	required
R.H.	right-hand
SCR.	screw
SOC.	socket
SPEC.	specifications
SPHER.	spherical
STL.	steel
SQ.	square
TYP.	typical
W.	width

General Job Content

I.	Types of Machines	Provide information on types and designs of drill presses, such as: 1. standard 2. single-spindle sensitive 3. radial 4. gang 5. multiple-spindle Point out that although treated as a category in itself, numerical control drilling follows the basic drilling theory and techniques. Numerically controlled drilling differs from basic drilling technique in that it uses a preprogrammed data system to position and feed the drills.
II.	Machine Parts	Point out and name the drill press parts: base, column, and table.
III.	Machine Accessories	
	A. Toolholding	Establish familiarity with drill press toolholding devices. Some of these include: sockets, sleeves, and drill chucks.
	B. Work holding	Discuss work holding devices, such as: vises, jigs, and clamps.
IV.	Cutting Tools	Describe the various types of cutting tools used: drills, machine reamers, hand reamers, counterbores, step drills, and countersinks. Identify the various parts of the cutting tools. Some parts of the drill are: body, shank, neck, tang, point, and web. Explain the procedures followed in grinding and sharpening the various cutting tools.
V.	Measurement and Inspection	List and explain the various types of measuring tools. These could include: micrometer, indicator, plug gages, and thread plug gages.
VI.	Blueprint Reading	Introduce and cover all necessary blueprint reading, such as:

1. theory of orthographic projection
2. language of lines
3. sectional views
4. tolerances

VII. Speeds and Feeds

The choice of speed and feed depends on:
1. composition and hardness of work material
2. cutting fluid efficiency
3. type and condition of machine
4. quality of finish required

Explain how to use the formula for calculating the speed of a drill. For example:

$$RPM = \frac{4 \times \text{cutting speed}}{\text{dia. of drill}}$$

Explain how to read and use tap drill charts.

Make available charts and tables which will enable the student to select proper speeds and feeds for hand or automatic operations.

Demonstrate how the diameter of the drill, the material being machined, the nature of the tool-holders, and the finish required all correlate with the proper choice of speeds and feeds.

VIII. Trade Mathematics

Introduce and cover all necessary trade mathematics, such as basic arithmetic, use of constants, and use of formulas.

IX. Coolants

Develop an understanding of coolants, including:
1. water base type
2. oil type
3. chemically active sulphur-fatty type
4. sulphur-mineral oils

Give examples of particular drilling conditions and the kind of coolant to use. Explain how the proper coolant can increase tool life, give a better finish, and help maintain close hole tolerance.

X. Care and Maintenance

Provide information concerning the care and maintenance of the various types of drill presses, such as: wiping the spindle hole before inserting a tool and making sure the machine is properly oiled and cleaned.

XI. Safety

Introduce the following safe working practices for operating the machine:
1. Wear close fitting clothes.
2. Wear safety glass.

3. Make sure the guards are kept in place.
4. Keep hands away from moving parts.
5. Know how to operate the controls.

Discuss particular dangers to avoid when operating the machine, such as:

1. Never leave the chuck key in the chuck.
2. Never hold work with your hands. Clamp the workpiece securely with standard devices such as: a drill vise, straps, C-clamps, parallel clamps, and stops.
3. Always use a brush to remove chips--never your hands or rags.
4. Keep your head away from the turning spindle to prevent hair entwining around it.
5. Never attempt to drill brass, copper, or bronze with a drill ground for steel. Demonstrate negative rake on the drill when drilling brass, copper, or bronze.
6. Ease up on the feed pressure as the drill begins to break through a hole.
7. Demonstrate the proper setup for drilling thin material including the holding device, the support, and the cutting tool.
8. Explain how the hand feed lever can injure the operator's face if he allows it to rotate uncontrolled while drilling to depth or when adjusting the column.

XII. Trade Terms

Explain all trade terms peculiar to the trade, such as press fit, pitch, jig, and flute.

XIII. Work Processes
A. Drilling

Mention that drilling is a very important phase of the trade, and that it is performed on a wide range of equipment. For example: the sensitive drill press, and the heavy duty radial drill press.

Continue by explaining that drills are classified as: number drills, letter drills, millimeter drills, and fractional drills.

Explain that in center drilling a combination drill and countersink is used to locate a hole and prevents the drill from wandering. Exhibit various sizes of center drills and explain how each is selected in proportion to the size of the drilled hole.

Discuss ways to achieve particular finishes and tolerances.

Explain the causes of drill failure, some of which are: speed too high, feed too high, and drill sharpening not properly done.

B. Boring

Explain that boring is done to enlarge and/or true a hole.

C. Counterboring

Discuss how a counterboring tool is used to enlarge a hole to a given diameter and depth, in order that a nut or bolthead may set flush or below the surface.

D. Countersinking

Point out that countersinking makes a cone-shaped enlargement on the end of a hole in order that a flathead screw seats properly to a particular depth.

E. Spot facing

Add that spot facing is similar to counterboring except that it is used to produce a shallow machined area on cast or forged surfaces.

F. Tapping

Explain how tapping is done with a drill press using friction drive tapping heads.

Point out how the actual cutting by the tap is done by the chamfer and the first full thread of the tap.

Impress upon the class the importance of runout, and tap alinement with the drilled hole. If these factors are not considered, then the threaded hole may not be square or the pitch diameter may be oversize. In extreme cases, these errors will result in broken taps.

Comment on some of the standard practices used in tapping:

1. Never tap through a hard bushing.
2. Countersink a hole before tapping.
3. Use spiral point or gun taps for through holes.

Direct attention to the importance of the tap and drill diameter and how it affects:

1. pitch diameter
2. depth of thread
3. amount of strain on the tap
4. quality of finish of the thread

Distribute material explaining the identification marking used on taps, for example:

$\frac{1}{2}$-13 UNC

G.	Gun Drilling	Describe the gun drill and its application. Point out that it is used on a machine designed especially for gun drilling. Explain why the cutting fluid must be run at high pressures for this kind of operation.
H.	Sub-land and Step Drilling	Discuss the application of subland drills and step drills. Show how the design of the drill allows for the drilling of two or more diameters, or for the combination of a drilling operation with counterboring, countersinking, or reaming.
I.	Core Drilling	Mention the core drill and why it is used to improve the concentricity of a cast hole.
J.	Reaming	Demonstrate how a reamer is used for good control of both size and finish. Explain the relationship between the size of the reamer and the predrilled size. Mention that reaming is done to make a hole round, straight, smooth, and accurate. Emphasize that the hole must be drilled undersize before reaming. For example: Drill 1/64" undersize for holes over 3/8" in diameter. State that reamers and drills are held in the same way when used. Also, that reaming requires a slower speed than drilling.
K.	Lapping and Honing	Demonstrate that under certain conditions abrasive cutting tools (either laps or hones) are used to size holes in hardened workpieces.

Job Sheets For Shop Projects

Unit No. *Operator's Job Title:* Drill Press Operator

Project I *Project Name:* Drill Stand

Job No. 1 *Job Name:* Drill Stand *D.O.T. No.* 606.380

Drawing Nos. 42 *Time:* 9 hrs.

Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the *Procedure* column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Operations:
1. Setting up.
2. Clamping
3. Drilling blind holes
4. Center drilling

Equipment:
Standard type drilling machine
Fractional drill gage
Set of fractional drills $\frac{1}{32}$" - $\frac{1}{2}$" in increments of $\frac{1}{64}$"
Drill chucks
Straight edge
6" rule
Clamping bolts
Drill Vise
Nos. 2 & 3 center drills

Materials:
One or more cast aluminum pcs. $1\frac{1}{2}$" x 3" x 6" from milling and layout operations

Selected references:
McCarthy & Smith, *Machine Tool Technology;* 3d edition
The Use and Care of Twist Drills

PROCEDURE	*TECHNIQUES AND RELATED INFO.*
1. Select a cast aluminum block from stock and remove all burrs.	1. Check overall dimensions and layout before drilling.
2. Set up a center drill in a quick-release drill chuck on a standard drill press.	2. Demonstrate the drill change-over procedure. Use a No. 1 center drill.
3. Select drill speed and set spindle depth stop.	3. Check the recommended drill speed on a drill speed chart.
4. Clamp a guide bar to the table.	4. The guide bar will assist in keeping the holes in a straight line. Calculate the distance the bar should be set from the centerline of the drill spindle.
5. Center drill all hole locations in the line of smallest holes.	5. Use cutting lubricant.
6. Remove the guide bar and reset to aline the middle line of holes.	6. Clean the guide bar and machine table with a brush. Calculate the distance the bar is to be set from the centerline of the spindle.
7. Center drill the middle line of holes.	7. Use a No. 3 center drill.
8. Remove the guide bar and reset and aline for the line of biggest holes.	8. Use a No. 3 center drill.

PROCEDURE	TECHNIQUES AND RELATED INFO.
9. Center drill the line of the biggest holes.	
10. Remove the guide bar and the center drill and clean the machine.	10. Use a brush and a wiping cloth.
11. Set the workpiece up in a drill vise.	11. Tap the workpiece down to seat it on the parallels, using a soft hammer.
12. Set up a $\frac{1}{32}$" drill and set the depth stop.	12. Check the drill size with a drill gage before chucking the drill. Discuss drill nomenclature.
13. Set the spindle r.p.m. and drill the $\frac{1}{32}$" hole to the depth indicated on the drawing.	13. Refer to a drill chart for spindle speed.
14. Drill all the holes $\frac{1}{32}$" through $\frac{1}{2}$", using the same procedure as above.	
15. Clean all tools and the machine on completion of the job.	15. Use a wiping cloth and brush. Do not leave an excess of oil on the parallels or the drills. Return all tools to proper storage.

Unit No. *Operator's Job Title:* Drill Press Operator

Project II *Project Name:* Parallel Clamp

Job No. 1A *Job Name:* Loose Jaw (inches) *D.O.T. No.* 606.380

Drawing Nos. 57A, Ref. No. 3 *Time:* 4 hrs.

Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the *Procedure* column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Operations:
1. Setting up
2. Blind hole drilling
3. Tapping
4. Counterboring
5. Through hole drilling

Equipment:
Gang drill press
$\frac{1}{4}$", $\frac{11}{32}$", and No. 29 drills
$\frac{7}{16}$" counterbore
8-32 UNC tap
Tapping head
8-32 Go-No-Go plug gage
Drill jig

Materials:
2 or more loose jaws SAE 1020 steel $\frac{1}{2}$" x $\frac{1}{2}$" x $3\frac{3}{8}$" from milling operations
Cutting oil

Selected references:
McCarthy & Smith, *Machine Tool Technology;* 3d edition
The Use and Care of Twist Drills

PROCEDURE	*TECHNIQUES AND RELATED INFO.*
1. Select stock from milling operations and remove all burrs.	1. Use a double-cut file. Check all dimensions before starting.
2. Clamp a workpiece in the drill jig.	2. Drill jig will have to be constructed.
3. Set up the cutting tools as follows: Spindle No. 1: $\frac{1}{4}$" drill Spindle No. 2: $\frac{11}{32}$" drill Spindle No. 3: No. 29 drill Spindle No. 4: $\frac{7}{16}$" counterbore Spindle No. 5: 8-32 UNC tap Spindle No. 6: 90° countersink	3. Clamp all tools securely. Use drill chucks for all drills, counterbores, and countersinks. Use a tapping head for the tap. Discuss turret head drill press as an alternate machine.
4. Set the spindle speed for each of the spindles.	4. Look up the recommended r.p.m. for each of the operations.
5. Drill the $\frac{1}{4}$", $\frac{11}{32}$", and No. 29 holes.	5. Set each of the spindle depth stops. Check the depths with a depth micrometer and correct the stops if necessary.
6. Tap the 8-32-UNC hole.	6. Tapping head setup is in accordance with type of head being used. Remove slip bushing from jig before tapping. Use cutting oil.

PROCEDURE	TECHNIQUES AND RELATED INFO.
7. Counterbore $\frac{7}{16}$" x $\frac{3}{32}$" deep in the $\frac{11}{32}$" hole.	7. Review counterbore types and sizes.
8. Remove the workpiece from the drill jig and take off all burrs by countersinking.	8. Use a 90° countersink.
9. Inspect the workpiece for hole sizes and depths.	9. Use a GO-No-Go thread plug gage.
10. Continue to machine remaining workpieces.	10. Make periodic inspections of workpieces.
11. On completion of all pieces clean the machine and remove all tools.	11. Clean tools with a rag. Return tools to proper storage.
12. Submit all work for inspection and grade.	

Unit No. *Operator's Job Title:* Drill Press Operator

Project II *Project Name:* Parallel Clamp

Job No. 1B *Job Name:* Loose Jaw (millimeters) *D.O.T. No.* 606.380

Drawing Nos. 57B, Ref. No. 3 *Time:* 4 hrs.

Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the *Procedure* column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Operations:
1. Setting up
2. Blind hole drilling
3. Tapping
4. Counterboring
5. Through hole drilling

Equipment:
Gang drill press
6.35 mm., 8.73 mm., and No. 29 drills
11.11 mm. counterbore
8-32 UNC tap
Tapping head
8-32 Go-No-Go plug gage
Drill jig

Materials:
2 or more loose jaws SAE 1020 12.8 mm. x 13 mm. x 85.7 mm. from milling operations
Cutting oil

Selected references:
McCarthy & Smith, *Machine Tool Technology;* 3d edition
The Use and Care of Twist Drills

PROCEDURE	*TECHNIQUES AND RELATED INFO.*
1. Select stock from milling operations and remove all burrs.	1. Use a double-cut file. Check all dimensions before starting.
2. Clamp a workpiece in the drill jig.	2. Drill jig will have to be constructed.
3. Set up the cutting tools as follows: Spindle No. 1: 6.35 mm. drill Spindle No. 2: 8.73 mm. drill Spindle No. 3: No. 29 drill Spindle No. 4: 11.11 mm. counterbore Spindle No. 5: 8-32 UNC tap Spindle No. 6: 90° countersink	3. Clamp all tools securely. Use drill chucks for all drills, counterbores, and countersinks. Use a tapping head for the tap. Discuss turret head drill press as an alternate machine.
4. Set the spindle speed for each of the spindles.	4. Look up the recommended r.p.m. for each of the operations.
5. Drill the 6.35 mm., 8.73 mm., and No. 29 holes.	5. Set each of the spindle depth stops. Check the depths with a depth micrometer and correct the stops if necessary.
6. Tap the 8-32 UNC hole.	6. Tapping head setup is in accordance with type of head being used. Remove slip bushing from jig before tapping. Use cutting oil.

PROCEDURE	TECHNIQUES AND RELATED INFO.
7. Counterbore 11.11 mm. x 2.38 mm. deep in the 8.73 mm. hole.	7. Review counterbore types and sizes.
8. Remove the workpiece from the drill jig and take off all burrs by countersinking.	8. Use a 90° countersink.
9. Inspect the workpiece for hole sizes and depths.	9. Use a Go-No-Go thread plug gage.
10. Continue to machine remaining workpieces.	10. Make periodic inspections of workpieces.
11. On completion of all pieces, clean the machine and remove all tools.	11. Clean tools with a rag. Return tools to proper storage.
12. Submit all work for inspection and grade.	

Unit No. *Operator's Job Title:* Drill Press Operator

Project II *Project Name:* Parallel Clamp

Job No. 2 *Job Name:* Threaded Jaw (inches) *D.O.T. No.* 606.380

Drawing Nos. 58A Ref. No. 3 *Time:* 3 hrs.

Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the *Procedure* column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Operations:
1. Tapping
2. Countersinking
3. Through hole drilling

Equipment:
Gang drill press
Drill jig
Drill chuck
Letter F drill
$\frac{5}{16}$"-18 UNC tap
Tapping head
90° countersink
Go-No-Go thread plug gage

Materials:
2 or more threaded jaws SAE 1020, $\frac{1}{2}$" x $\frac{1}{2}$" x $3\frac{3}{8}$" from milling operations

Selected references:
McCarthy & Smith, *Machine Tool Technology;* 3d edition
The Use and Care of Twist Drills

PROCEDURE	*TECHNIQUES AND RELATED INFO.*
1. Select stock from milling operations and remove all burrs.	1. Use a double-cut file. Check all sizes before proceeding.
2. Place workpiece in drill jig and clamp it.	2. Drill jig will have to be constructed.
3. Set up the cutting tools as follows: Spindle No. 1: Letter F drill Spindle No. 2: $\frac{5}{16}$"-18 UNC tap Spindle No. 3: 90° countersink	3. Use a 2-fluted gun tap.
4. Adjust the speeds and depth stops.	4. Calculate the r.p.m. in each case using the formula $RPM = \frac{4xCS}{D}$ or use a drill speed chart. Set depth stop so the drill does not penetrate the machine table.
5. Drill the 2 holes (letter F drill) for the $\frac{5}{16}$"-18 UNC tap.	5. Use cutting oil.
6. Tap the 2 holes.	6. Use cutting oil.
7. Remove the work from the drill jig and take off all burrs.	7. Use a 90° countersink.

PROCEDURES	TECHNIQUES AND RELATED INFO.
8. Inspect workpiece.	8. Remove all burrs and check the work with a $\frac{5}{16}$" - 18 UNC Go-No-Go thread plug gage.
9. Remove all tools. Clean the machine and tools.	9. Use a wiping cloth. Return all tools to their proper locations.
10. Submit all work for inspection and grade.	

Unit No. *Operator's Job Title:* Drill Press Operator

Project III *Project Name:* Parallels

Job No. 1A *Job Name:* Parallels (inches) *D.O.T. No.* 606.380

Drawing Nos. 50A *Time:* 6 hrs.

Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the *Procedure* column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Operations:
1. Setting up fixture
2. Setting up spindle
3. Through hole drilling
4. Multiple spindle drilling

Equipment:
10-spindle drilling machine
Suitable drilling fixture
10 suitable $\frac{5}{16}$" drills

Materials:
2 or more parallels from milling operations

Selected references:
McCarthy & Smith, *Machine Tool Technology;* 3d edition

PROCEDURE	*TECHNIQUES AND RELATED INFO.*
1. Select workpieces from milling operations and remove all burrs.	1. Inspect workpieces for sizes before proceeding.
2. Set up the drilling fixture.	2. Discuss the design and purposes of work holding fixtures.
3. Set up the 10 tapered-shank drills of $\frac{5}{16}$" dia.	3. Explain the Morse tapered system as applied to machine tools and drill diameters. Be sure all mating surfaces are clean and free of nicks and dirt.
4. Clamp the work in the drill fixture.	
5. Aline the 10 drills to the drill bushings and clamp the spindles in place. If space is restricted, do 5 holes at a time in two settings.	5. Fixtures are usually provided with hardened guide bushings. Discuss the use of laps to fit hardened bushings.
6. Set the spindle speed, depth stops, and all other necessary controls.	6. Be sure all drills are of the same approximate length. Demonstrate the freehand method of sharpening a twist drill. Use a drill point gage.
7. Set all coolant nozzles.	7. Coolant flow should be directed on the drill bushings.

PROCEDURE	TECHNIQUES AND RELATED INFO.
8. Drill the holes.	8. Observe the drill entering the drill bushings for drill deflection.
9. Remove and inspect the workpiece.	
10. If first piece is correct, continue to drill the assigned number of pieces. If not, make necessary adjustments.	10. Clean the fixture of chips before inserting each new piece.
11. Remove all tools. Clean the tools and machine on completion of the work.	11. Use a shop cloth. Return all tools to their proper storage places.
12. Submit all workpieces for inspection and grade.	

Unit No. *Operator's Job Title:* Drill Press Operator

Project III *Project Name:* Parallels

Job No. 1B *Job Name:* Parallels (millimeters) *D.O.T. No.* 606.380

Drawing Nos. 50B *Time:* 6 hrs.

Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the *Procedure* column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Operations:
1. Setting up fixture
2. Setting up spindle
3. Through hole drilling
4. Multiple spindle drilling

Equipment:
10-spindle drilling machine
Suitable drilling fixture
10 suitable 8 mm. drills

Materials:
2 or more parallels from milling operations SAE 1020
13 mm. x 19 mm. x 150 mm.

Selected references:
McCarthy & Smith, *Machine Tool Technology;* 3d edition
The Use and Care of Twist Drills

PROCEDURE	*TECHNIQUES AND RELATED INFO.*
1. Select workpieces from milling operations and remove all burrs.	1. Inspect workpieces for sizes before proceeding.
2. Set up the drilling fixture.	2. Discuss the design and purposes of work holding fixtures.
3. Set up the 10 tapered-shank drills of 8 mm. dia.	3. Explain the Morse tapered system as applied to machine tools and drill diameters. Be sure all mating surfaces are clean and free of nicks and dirt.
4. Clamp the work in the drill fixture.	
5. Aline the 10 drills to the drill bushings and clamp the spindles in place. If space is restricted, do 5 holes at a time in two settings.	5. Fixtures are usually provided with hardened guide bushings. Discuss the use of laps to fit hardened bushings.
6. Set the spindle speed, depth stops, and all other necessary controls.	6. Be sure all drills are of the same approximate length. Demonstrate the freehand method of sharpening a twist drill. Use a drill point gage.
7. Set all coolant nozzles.	7. Coolant flow should be directed on the drill bushings.

PROCEDURE	TECHNIQUES AND RELATED INFO.
8. Drill the holes.	8. Observe the drill entering the drill bushings for drill deflection.
9. Remove and inspect the workpiece.	
10. If first piece is correct, continue to drill the assigned number of pieces. If not, make necessary adjustments.	10. Clean the fixture of chips before inserting each new piece.
11. Remove all tools. Clean the tools and machine on completion of the work.	11. Use a shop cloth. Return all tools to their proper storage places.
12. Submit all workpieces for inspection and grade.	

Unit No. *Operator's Job Title:* Drill Press Operator

Project IV *Project Name:* Bench Vise

Job No. 1 *Job Name:* Screw *D.O.T. No.* 606.380

Drawing Nos. 16 *Time:* 1½hrs.

Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the *Procedure* column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Operations:
1. Through hole drilling
2. Center drilling

Equipment:
Standard drill press
V-block
Speed chuck
90° countersink
$\frac{17}{64}$" drill

Materials:
Bench vise screw from lathe operations

Selected references:
McCarthy & Smith, *Machine Tool Technology;* 3d edition
The Use and Care of Twist Drills

PROCEDURE	*TECHNIQUES AND RELATED INFO.*
1. Select workpiece from lathe and layout operations.	1. Check all dimensions before proceeding.
2. Clamp workpiece in a suitable V-block.	2. Review uses and purposes of V-blocks as well as the various types. Do not clamp on the thread.
3. Clamp a center drill in the speed chuck.	3. Point out that center drills come in various designs and sizes. Also, that there are charts recommending the sizes to be used. Illustrate the various kinds of drill chucks available and their purposes.
4. Set the spindle speed and center drill.	4. Use a moderate feed pressure.
5. Remove the center drill and insert a $\frac{17}{64}$" dia. drill.	5. Point out that the spindle does not have to be stopped to change the cutting tools.
6. Drill the $\frac{17}{64}$" hole through the piece.	6. Use cutting oil. Be careful that the V-block does not tilt which could result in a slanted hole. Use a jack if necessary.

PROCEDURE	TECHNIQUES AND RELATED INFO.
7. Remove the $\frac{17}{64}$" drill and insert a 60° countersink.	
8. Break all sharp edges around the hole.	8. Point out that countersinks come in various angles and diameters.
9. Clean all tools and machine.	9. Return all tools to proper locations.
10. Submit for inspection and grade.	

Unit No. *Operator's Job Title:* Drill Press Operator

Project IV *Project Name:* Bench Vise

Job No. 2 *Job Name:* Fixed and Movable Jaws *D.O.T. No.* 606.380

Drawing Nos. 17 *Time:* 3 hrs.

Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the *Procedure* column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Operations:
1. Center drilling
2. Drilling
3. Deep hole drilling
4. Setting up
5. Hand tapping

Equipment:
Standard drill press
$\frac{3}{16}$", $\frac{27}{64}$", and $\frac{31}{64}$" drills
$\frac{1}{2}$" rose reamer
Drill chuck
$\frac{1}{2}$"-13 UNC tap
Tap wrench
Drill chuck center
Drill vise
90° countersink

Materials:
Fixed and movable jaws from lathe and layout operations

Selected references:
McCarthy & Smith, *Machine Tool Technology;* 3d edition
The Use and Care of Twist Drills

PROCEDURE	*TECHNIQUES AND RELATED INFO.*
1. Select stock from lathe and layout operations.	1. Remove all burrs and check the sizes and layout before proceeding.
2. Clamp the work to the machine table in the step jaws of a drill vise.	
3. Mount a center drill in the drill chuck and center drill all hole locations.	
4. Remove the center drill and replace it with a $\frac{3}{16}$" drill. Drill all hole locations (5 holes).	4. Review the reasons for the use of pilot holes. Use cutting oil. Do not allow chips to clog the drill flutes.
5. Remove the $\frac{3}{16}$" drill.	
6. Mount a $\frac{31}{64}$" drill in the machine spindle.	
7. Drill the two outer holes.	
8. Replace the $\frac{31}{64}$" drill with the $\frac{27}{64}$" tap drill.	
9. Drill the $\frac{27}{64}$" hole.	
10. Remove the $\frac{27}{64}$" drill and replace with a $\frac{1}{2}$" rose reamer.	10. Check the condition of the reamer before using. Check the reamer dia. with a micrometer.

PROCEDURE	TECHNIQUES AND RELATED INFO.
11. Ream the two outer holes.	11. Use cutting oil.
12. Replace the reamer with a drill chuck and a 90° countersink.	
13. Break all sharp edges on both ends of all holes.	
14. Insert a drill chuck center in the drill chuck and aline it with the $\frac{27}{64}$" hole.	14. Center will be used to keep tap square with hole.
15. Tap the hole.	15. Use a flat tap wrench to drive the tap by hand. (Demonstrate the procedure.)
16. Send the work to the band saw to be cut into the two jaws and then to milling for finishing.	
17. On return from milling, ream the remaining middle $\frac{1}{2}$" hole in the movable jaw.	
18. Clean all tools and the machine.	18. Return all tools to the proper places.
19. Submit for inspection and grade.	

Unit No. *Operator's Job Title:* Drill Press Operator

Project V *Project Name:* Arbor Press

Job No. 1 *Job Name:* Base *D.O.T. No.* 606.380

Drawing Nos. 33 *Time:* 3 hrs.

Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the *Procedure* column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Operations:
1. Small hole drilling
2. Clamping
3. Reaming
4. Blind hole drilling
5. Tapping

Equipment:
Standard drill press
$\frac{1}{8}$", $\frac{3}{16}$" and $\frac{15}{64}$" drills
$\frac{1}{4}$" rose reamer
Letter F drill
$\frac{3}{8}$" - 16 UNC tap
T-bolts and nuts
Gooseneck clamps
Parallels
Angle plate
Vise
Tapping head

Materials:
Arbor press base 1" x 3" x $3\frac{1}{4}$" from milling and layout operations

Selected references:
McCarthy & Smith. *Machine Tool Technology;* 3d edition
The Use and Care of Twist Drills

PROCEDURE	*TECHNIQUES AND RELATED INFO.*
1. Select stock from milling and layout operations before the slots are milled.	1. Inspect workpiece for correctness of sizes before proceeding with the drilling.
2. Clamp the workpiece in a drill vise with step jaws.	2. Tap the work down with a soft hammer to seat it.
3. Insert a $\frac{1}{8}$" drill in the drill chuck.	3. Use a quick release chuck. Check the drill for runout.
4. Drill the two $\frac{1}{8}$" holes.	4. Do not allow the chips to become clogged in the flutes of the drill. Raise spindle frequently. Use cutting oil.
5. Remove the $\frac{1}{8}$" drill and replace it with a $\frac{3}{16}$" drill.	5. Do not allow the chips to become clogged in the flutes of the drill. Raise spindle frequently. Use cutting oil.
6. Drill the two $\frac{3}{16}$" holes.	6. Clear the chips from the hole frequently.
7. Remove the $\frac{3}{16}$" drill, insert a $\frac{15}{64}$" drill, and drill the hole for the $\frac{1}{4}$" reamer.	7. Drill to $\frac{1}{8}$" depth and check hole for oversize condition with the reamer before drilling through.

PROCEDURE	TECHNIQUES AND RELATED INFO.
8. Remove the $\frac{15}{64}$" drill, replace it with a $\frac{1}{4}$" rose reamer, and ream the hole.	8. Check the reamer to see that it is in good condition before using it. Use cutting oil.
9. Remove the workpiece from the vise and clamp it to an angle plate.	9. Check the angle plate for squareness. Use parallel clamps.
10. Locate the point for drilling the tapped hole and clamp the angle plate to the machine table.	10. Use T-bolts, straps, clamps, and step blocks.
11. Set the depth stop to $\frac{3}{4}$" and drill the $\frac{5}{16}$" drill hole for the $\frac{3}{8}$" - 16 UNC tapped hole.	11. Use cutting oil. Hole depth is at full dia.
12. Open the $\frac{5}{16}$" hole to $\frac{3}{8}$" dia. to a depth of $\frac{1}{8}$".	12. This will provide relief for the tap.
13. Tap the $\frac{3}{8}$" thread.	13. Use an extension tap. Follow local shop setup procedure.
14. Clean machine and all tools	14. Use a brush and a shop cloth.
15. Return all tools to their proper storage places.	
16. Submit work for inspection and grade.	

Unit No. *Operator's Job Title:* Drill Press Operator

Project VI *Project Name:* Tap Wrench

Job No. 1 *Job Name:* Tap Wrench Body *D.O.T. No.* 606.380

Drawing Nos. 21 *Time:* 1½ hrs.

Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the *Procedure* column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Operations:
1. Setting up
2. Drilling
3. Alining spindle with hole layout

Equipment:

Standard drill press	90° countersink
Center drill	Rapid index head
Drill chuck	¾" collet
¼" drill	Clamps

Materials:
Wrench body from lathe and layout operations

Selected references:
McCarthy & Smith, *Machine Tool Technology;* 3d edition
The Use and Care of Twist Drills

PROCEDURE	*TECHNIQUES AND RELATED INFO.*
1. Select material from lathe operations and layout. Remove all burrs.	1. Check all sizes before proceeding with drilling operations.
2. Clamp work in a rapid index head with a ¾" collet.	2. Aline spindle with hole layout and index head with table. Use a surface gage and suitable clamp.
3. Insert a drill chuck in the spindle.	3. Clean the tapered shank and the spindle hole with a shop cloth.
4. Clamp a center drill in the drill chuck and center drill for the ¼" hole.	4. Check drill for runout. Use cutting oil.
5. Drill the ¼" hole through the ¾" dia.	5. Ease the feed pressure when the drill breaks through the work.
6. Remove the ¼" drill and replace it with a 90° countersink.	
7. Countersink both ends of the ¼" hole.	
8. Remove all tools. Clean the tools and the machine.	8. Return all tools to proper storage. Use a rag to remove all chips and oil.
9. Submit job for inspection and grade.	
10. Send to lathe for drilling and tapping of the 10-32 UNC-2A hole.	

Unit No. *Operator's Job Title:* Drill Press Operator

Project VII *Project Name:* 1-2-3 Block

Job No. 1 *Job Name:* 1-2-3 Block *D.O.T. No.* 606.380

Drawing Nos. 45.1 *Time:* 5 hrs.

Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the *Procedure* column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Operations:
1. Setting up
2. Countersinking
3. Reaming
4. Drilling

Equipment:
Standard drill press
Box drill jig
$\frac{31}{64}$" drill
$\frac{1}{2}$" reamer
Fractional drill gage
Countersink

Materials:
2 or more pcs. SAE 1020
1.020" x 2.020" x 3.020"
from milling operations

Selected references:
McCarthy & Smith, *Machine Tool Technology;* 3d edition
The Use and Care of Twist Drills

PROCEDURE	*TECHNIQUES AND RELATED INFO.*
1. Select material from milling operations. Remove all burrs.	1. Check sizes before proceeding with drilling operations.
2. Chuck a $\frac{31}{64}$" drill.	2. Check the drill size with a drill gage.
3. Clamp the workpiece in a drill jig.	3. For hole location, use a plate template or a box drill jig.
4. Select and set spindle speed and depth stop.	4. Look up speed on a chart.
5. Drill the 13 holes. Drill first hole to $\frac{1}{8}$" depth and check hole for oversize condition before drilling through.	5. Use cutting oil and power feed.
6. Replace the drill with a $\frac{1}{2}$" rose reamer.	6. If a box jig is used, change the slip bushings to accommodate the $\frac{1}{2}$" reamer, otherwise follow local shop practice. Another method that could be used is to layout the holes and drill them while holding the work in a drill vise.
7. Change the spindle speed and the depth stop.	
8. Ream all 13 holes.	8. Use cutting oil and hand feed.

PROCEDURE	TECHNIQUES AND RELATED INFO.
9. Replace the reamer with a $\frac{3}{8}$" 90° countersink and change the spindle speed.	9. Use a slow speed to avoid chatter.
10. Remove the work from the box drill jig. Clean the work and the machine table.	10. Use a brush.
11. Remove all burrs.	11. Use a double-cut file.
12. Set the work up in a drill vise.	
13. Set the depth stop to countersink to $\frac{1}{32}$" depth.	13. CAUTION: Each dimension will require a change in the depth stop.
14. Countersink all 13 holes, both ends.	
15. Clean the machine and all tools.	15. Return all tools to the proper locations.
16. Submit all work for inspection and grade.	

Unit No. *Operator's Job Title:* Drill Press Operator

Project VIII *Project Name:* Micrometer Boring Head

Job No. 1 *Job Name:* Dovetail Blocks *D.O.T. No.* 606.380

Drawing Nos. 22.2 *Time:* $2\frac{1}{2}$ hrs.

Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the *Procedure* column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Operations:
1. Center drilling
2. Through hole drilling
3. Countersinking
4. Subland drilling

Equipment:
Standard drill press
No. 2 center drill
$\frac{11}{64}$" drill
$\frac{21}{64}$" x .437" subland drill
Drill vise and special clamping jaw
Flush gage
90° countersink
Drill gage

Materials:
2 dovetail blocks from milling operations

Selected references:
McCarthy & Smith, *Machine Tool Technology;* 3d edition
The Use and Care of Twist Drills

PROCEDURE	*TECHNIQUES AND RELATED IN*
1. Select stock from milling operations and remove all burrs.	1. Check all sizes before proceeding.
2. Clamp the laid-out dovetail block in a drill vise using a special 8° soft, parallel clamping block.	2. Either an 8° clamping block should be constructed or an alternate machining method. The alternate method could be to cut the block in two and clamp the pieces in a vise.
3. Clamp a center drill in a drill chuck and center drill all 6 holes.	3. Set the spindle depth stop to obtain a $\frac{7}{32}$" dia. countersink. Use cutting oil.
4. Set up a $\frac{11}{64}$" drill and drill 4 holes.	4. Check the drill size using a fractional drill gage. Do not allow drill to become clogged with chips.
5. Remove the $\frac{11}{64}$" drill and replace it with a $\frac{21}{64}$" x .437" subland drill.	5. Describe the advantages and the uses of subland and step drills.
6. Set the r.p.m. and the depth stop.	
7. Drill and counterbore the $\frac{21}{64}$" x .437" holes to .343" depth.	7. Use cutting oil. Check the counterbore depth using a flush gage.
8. Remove the workpiece from the vise and turn it and the 8° clamping block over.	8. Clean and remove burrs from workpiece, clamping block, and vise.

PROCEDURE	TECHNIQUES AND RELATED INFO.
9. Remove the subland drill and replace it with a 90° countersink.	
10. Adjust the r.p.m. of the machine spindle.	10. Calculate the r.p.m. using the formula $R.P.M. = \frac{4 \times CS}{D}$ or a chart.
11. Countersink the four $\frac{11}{64}$" holes to $\frac{7}{32}$" dia.	11. Set the spindle depth stop.
12. Countersink the two $\frac{21}{64}$" holes to break the sharp edges.	12. $\frac{11}{32}$" dia. should be suitable.
13. Clean all tools and the machine.	13. Return all tools to proper storage places.
14. Submit workpiece for inspection and grade.	14. Send to Power Saws and Milling Machine for completion of operations.

Unit No. *Operator's Job Title:* Drill Press Operator

Project IX *Project Name:* Precision Step Block

Job No. 1 *Job Name:* Precision Step Block *D.O.T. No.* 606.380

Drawing Nos. 44 *Time:* $2\frac{1}{2}$ hrs.

Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the *Procedure* column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Operations:
1. Clamping
2. Center drilling
3. Drilling
4. Counterboring
5. Countersinking
6. Spindle alinement
7. Deep hole drilling

Equipment:
Standard drill press
Drill vise
T-bolts and nuts
Dial indicator
Wiggler
Center drill
$\frac{5}{16}$" drill
$\frac{7}{16}$" counterbore
$\frac{3}{4}$" x 90° countersink

Materials:
Tool steel step block from milling and layout operations

Selected references:
McCarthy & Smith, *Machine Tool Technology;* 3d edition
The Use and Care of Twist Drills

PROCEDURE	*TECHNIQUES AND RELATED INFO.*
1. Check the machine table for squareness to the drill press spindle.	1. Use a dial indicator mounted in a drill chuck on a bent bar, and sweep the table by revolving the spindle. Indicator should read the same at four points opposite to each other. Adjust table if necessary.
2. Select stock from milling and layout operations and check dimensions.	2. Do not proceed if dimensions are not correct.
3. Clamp the work in a vise with step jaws.	3. Use a soft hammer to seat the work.
4. Set up a centerfinder and locate the centerlines for the hole.	4. Demonstrate the use of the centerfinder.
5. Clamp the vise securely when location is found.	5. Check with centerfinder again, after clamping the vise, to be sure the latter did not shift.
6. Centerdrill for the $\frac{5}{16}$" hole.	
7. Remove the center drill and drill the $\frac{5}{16}$" hole through the work.	7. Use cutting oil and raise the spindle frequently to clear out the chips.
8. Remove the $\frac{5}{16}$" drill and replace it with a $\frac{7}{16}$" counterbore.	8. Review types and sizes of counterbores.

PROCEDURE	TECHNIQUES AND RELATED INFO.
9. Set the r.p.m. and counterbore to $\frac{5}{16}$" depth.	9. Use cutting oil. Set the depth stop. Use a moderate hand feed rate.
10. Remove the counterbore and set up a 90° countersink.	
11. Countersink to $\frac{1}{16}$" depth.	11. Use a slow spindle speed to avoid chatter. Use cutting oil.
12. Remove the burrs and turn the workpiece over in the vise.	12. Clean the vise and put side D down on the parallels.
13. Loosen the vise and chuck a $\frac{7}{16}$" counterbore.	13. Aline the pilot of the counterbore in the $\frac{5}{16}$" hole and carefully clamp the vise.
14. Counterbore the $\frac{5}{16}$" hole to a depth of $\frac{5}{16}$".	14. Use cutting oil and a moderate feed pressure.
15. Remove the counterbore and chuck a 90° countersink.	
16. Countersink to $\frac{1}{16}$" depth.	
17. Remove burrs.	17. Clean all tools and machine. Return all tools to their proper locations.
18. Submit work for inspection and grade.	

Unit No. *Operator's Job Title:* Drill Press Operator

Project X *Project Name:* Motor Plate

Job No. 1 *Job Name:* A, B, and C Holes *D.O.T. No.* 606.380

Drawing Nos. 72 *Time:* 2 hrs.

Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the *Procedure* column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Operations:
1. Locating spindle in relation to layout
2. Center drilling
3. Drilling
4. Counterboring
5. Facing
6. Back facing

Equipment:
Single-spindle upright drill or small radial drill
Drill press vise with step jaws
$\frac{13}{32}$" and $\frac{19}{32}$" counterbores
Depth gage
$\frac{7}{8}$" facer with $\frac{13}{32}$" pilot
Mill file
$1\frac{1}{2}$" back facer with $\frac{19}{32}$" pilot
Center drill
$\frac{19}{32}$" drill

Materials:
$1\frac{1}{4}$" X 4 $\frac{1}{4}$" x $6\frac{1}{4}$" cast iron plate from milling and layout operations

Selected references:
McCarthy & Smith. *Machine Tool Technology;* 3d edition
The Use and Care of Twist Drills

PROCEDURE	*TECHNIQUES AND RELATED INFO.*
1. Select stock and deburr.	1. Check overall dimensions and layout before starting.
2. Insert part, clamp, and seat in step jaws.	
3. Mount center drill in chuck, and move vise on table until center punch mark is directly below the drill for one of the "A" holes.	3. Discuss alternate methods. For example: using wiggler or spotting with small diameter drill.
4. Clamp vise to table.	4. If radial drill is being used, move head over punch mark.
5. Hand feed center drill to full 60° depth.	
6. Drill the $\frac{13}{32}$" hole through.	6. Use power feed .005"-.007" and proper r.p.m.
7. Counterbore .594"x.531"deep.	7. Use hand feed and proper r.p.m. Demonstrate use of depth gage.
8. Loosen vise and repeat above procedure for the other 3 "A" holes.	
9. Move to the "B" hole and drill $\frac{13}{32}$" through.	9. Use power feed .005"-.007" and proper r.p.m.

PROCEDURE	TECHNIQUES AND RELATED INFO.
10. Face to depth with $\frac{7}{8}$" facer.	10. Use hand feed.
11. Move to location of "C" hole.	
12. Drill $\frac{19}{32}$" hole through.	12. Use power feed .005"-.007" and proper r.p.m.
13. Insert back facer with $\frac{19}{32}$" shank in chuck and drop through hole. Attach facer tool on shank and raise spindle up to face underside of part.	13. Hand feed upward to clean up surface. Discuss the importance of proper tool assembly so that the opposing cutting force does not pull out the back facer.

Unit No. *Operator's Job Title:* Drill Press Operator

Project X *Project Name:* Motor Plate

Job No. 2 *Job Name:* D Holes *D.O.T. No.* 606.380

Drawing Nos. 72 *Time:* $1\frac{1}{2}$ hrs.

Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the *Procedure* column below as shown on the drawings, in accordance with with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Operations:
1. Locating spindle in relation to layout
2. Center drilling
3. Drilling
4. Machine reaming
5. Hand reaming

Equipment:
Single-spindle upright drill or small radial drill
Drill press vise with step jaws
Center drill
$\frac{15}{32}$" drill
$\frac{1}{2}$" drill
$\frac{1}{2}$" Go-No-Go plug gage
$\frac{1}{2}$" spiral flute expansion hand reamer

Materials:
$1\frac{1}{4}$" x $4\frac{1}{4}$" x $6\frac{1}{4}$" cast iron plate
$\frac{1}{2}$" machine reamer (undersize)
Flat tap wrench

Selected references:
McCarthy & Smith, *Machine Tool Technology;* 3d edition
The Use and Care of Twist Drills

PROCEDURE	*TECHNIQUES AND RELATED INFO.*
1. Locate spindle on layout for one "D" hole and center drill it.	1. Use same procedure as for holes A, B, and C in Job 1.
2. Drill through with $\frac{15}{32}$" drill (2 "D" holes).	2. Use .007" feed and proper r.p.m.
3. Ream $\frac{1}{2}$"-.010 hole. Check with a micrometer. Locate the chamfer of the reamer in the drilled holes. Repeat for other "D" hole.	3. Discuss the differences between rose and chucking reamers. Engage feed lever then engage r.p.m. lever. Feed .015". The r.p.m. for reaming is one-half of that for drilling.
4. Check the holes with a .500" Go-No-Go gage.	4. At this stage neither end should enter.
5. Use expansion hand reamer until the Go-Gage enters and the No-Go does not.	5. Demonstrate how to back the reamer off so it just passes through the hole; then expand it $\frac{1}{8}$ turn for each pass.

Unit No. *Operator's Job Title:* Drill Press Operator

Project X *Project Name:* Motor Plate

Job No. 3 *Job Name:* E Holes *D.O.T. No.* 606.380

Drawing Nos. 72 *Time:* 2 hrs.

Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the *Procedure* column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Operations:
1. Locating spindle in relation to layout
2. Center drilling
3. Drilling
4. Countersinking
5. Power tapping

Equipment:
Single-spindle upright drill or small radial drill
Drill Press vise
Center drill
$\frac{5}{16}$" drill
$\frac{3}{8}$"-16 plug tap
$\frac{3}{8}$"-16 plug thread gage (Go-No-Go)
90° countersink

Materials:
$1\frac{1}{8}$" x $4\frac{1}{4}$" x $6\frac{1}{4}$" cast iron plate

Selected references:
McCarthy & Smith, *Machine Tool Technology;* 3d edition
The Use and Care of Twist Drills

PROCEDURE	*TECHNIQUES AND RELATED INFO.*
1. Locate the spindle on the layout for one of the "E" holes and center drill it.	1. Use same procedure as for holes A,B,C, and D.
2. Drill through with $\frac{5}{16}$" drill. Repeat for the other 3 "E" holes.	2. Use .007" feed. Figure r.p.m.
3. Countersink 90° to width $\frac{13}{32}$" at top of hole.	3. Discuss purpose of countersinking.
4. Tap through $\frac{3}{8}$"-16. Use soluble oil.	4. Use proper r.p.m. Put spindle in forward, and allow tap to pull itself in and through the hole. Before tap reaches end of threads, reverse it and apply light lifting pressure.
5. Check threads with $\frac{3}{8}$"-16 thread plug gage. The "Go" end should enter freely, the "No-Go" end only 1 to $1\frac{1}{2}$ threads deep.	

Unit No. *Operator's Job Title:* Drill Press Operator

Project X *Project Name:* Motor Plate

Job No. 4 *Job Name:* F and G Holes *D.O.T. No.* 606.380

Drawing Nos. 72 *Time:* 3 hrs.

Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the *Procedure* column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Operations:
1. Locate spindle in relation to layout
2. Center drilling
3. Drilling
4. Powertapping

Equipment:
Single-spindle upright drill or small radial drill
$\frac{37}{64}$" drill
Letter R drill
$\frac{3}{8}$"-18 National pipe tap
$\frac{1}{8}$"-27 pipe tap
$\frac{7}{16}$" counterbore
$\frac{1}{8}$"-27 NP thread plug gage
$\frac{3}{8}$"-18 hole gage
$\frac{1}{8}$"-27 hole gage
$\frac{3}{8}$"-18 NP thread plug gage

Materials:
$1\frac{1}{4}$" x $4\frac{1}{4}$" x $6\frac{1}{4}$" cast iron plate

Selected references:
McCarthy & Smith, *Machine Tool Technology;* 3d edition
The Use and Care of Twist Drills

PROCEDURE	*TECHNIQUES AND RELATED INFO.*
1. Locate spindle in relation to layout for "F" holes and center drill.	1. Use same procedure as for holes A, B, and C.
2. Drill through with $\frac{37}{64}$" drill (2 holes).	2. Demonstrate that hole gage should not enter hole.
3. Tap with $\frac{3}{8}$"-18 pipe tap (2 holes).	3. Discuss importance of thread depth. Tap should not enter over half the threads.
4. Clean out thread and check with thread gage. Repeat until desired depth is obtained.	4. Gage should not go beyond ground flat on gage.
5. Recheck with hole gage.	5. After tapping to proper depth, the hole gage should not enter hole more than 1 to $1\frac{1}{2}$ threads deep.
6. Turn part on end, locate the spindle on the layout for hole "G", and center drill.	6. Use same procedure as for holes A, B, and C.
7. Drill through with R drill.	7. Demonstrate that the hole gage should not enter the hole.
8. Tap with $\frac{1}{8}$"-27 pipe tap.	8. Use same procedure as for hole F, steps 3 and 5.
9. Counterbore $\frac{7}{16}$" x .0625.	9. Use depth gage.

Unit No. *Operator's Job Title:* Drill Press Operator

Project X *Project Name:* Motor Plate

Job No. 5 *Job Name:* H Hole *D.O.T. No.* 606.380

Drawing Nos. 72 *Time:* 2 hrs.

Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the *Procedure* column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Operations:
1. Locating spindle in relation to layout
2. Drilling
3. Machine reaming
4. Hand reaming
5. Countersinking

Equipment:
Center drill
$\frac{7}{32}$" drill
No. 4 straight or spiral-flute taper-pin reamer
Tap wrench
Hammer
No. 4 taper pin
Drill press vise

Materials:
$1\frac{1}{4}$" x $4\frac{1}{4}$" x $6\frac{1}{4}$" cast iron plate

Selected references:
McCarthy & Smith, *Machine Tool Technology;* 3d edition
The Use and Care of Twist Drills

PROCEDURE	*TECHNIQUES AND RELATED INFO.*
1. Turn the part back to its original position in the vise and position the spindle on the layout for hole H. Center drill for the hole.	1. Use the same procedure as for holes A,B, and C.
2. Drill through with $\frac{7}{32}$" drill.	
3. Machine ream part way. Use hand feed.	3. Use r.p.m. of half the drill speed.
4. Clean out hole, try pin, ream until pin extends out top of hole about $\frac{1}{4}$".	
5. Hand ream until pin extends out about $\frac{1}{8}$".	5. Clean hole and pin. Oil pin to prevent pickup. Tap pin into position with hammer. Rounded portion of large dia. of pin should be flush or barely above surface.
6. Countersink both sides of all holes to break edges $\frac{1}{32}$".	
7. After completion of piece, clean the machine.	7. Clean tools with a rag. Return tools to proper storage places.
8. Submit all work for inspection and grade.	

Unit No. *Operator's Job Title:* Drill Press Operator

Project XI *Project Name:* Close Quarters Hacksaw

Job No. 1 *Job Name:* Adjustable blade retainer *D.O.T. No.* 606.380

Drawing Nos. 14 *Time:* $\frac{1}{2}$ hr.

Performance Objectives:
Using only the equipment and materials listed here, the student will be able to perform the drilling operations described in the *Procedure* column below as shown on the drawings, in accordance with the time and accuracy requirements specified. After completing this job, the student will be able to complete similar jobs with like specifications.

Operations:
1. Setting up
2. Drilling
3. Drill jig clamping

Equipment:
Sensitive single-spindle drill press
Drill jig
No. 31 drill

Materials:
One or more retainers from lathe and layout operations CRS 1020, $2\frac{3}{16}$" long

Selected references:
McCarthy & Smith, *Machine Tool Technology;* 3d edition
The Use and Care of Twist Drills

PROCEDURE	*TECHNIQUES AND RELATED INFO.*
1. Select workpiece from lathe and layout operations and remove all burrs.	1. Inspect workpieces for size before proceeding.
2. Set up a No. 31 drill in the drill chuck.	2. Discuss the reasons for using high r.p.m. when drilling small diameter holes.
3. Clamp the work in a drill jig.	3. Drill jig will have to be constructed. Explain other alternatives such as "V"-blocks, superspacers, and universal shaft jigs.
4. Drill the No. 31 hole in the $\frac{1}{2}$" diameter.	4. Use oil, Aline drill in bushing.
5. Drill the No. 31 hole in the $\frac{1}{4}$" diameter.	
6. Remove the workpiece from the drill jig and inspect it.	6. Remove all burrs.
7. Remove all tools.	7. Clean the machine and tools. Return tool to proper locations.
8. Submit work for inspection and grade.	

Bibliography

Anderson, James & Tatro, Earl E. *Shop theory;* 6th ed. New York, N.Y. McGraw-Hill. 1974.

Beloit Tool Corp. *U.S.A. goes metric;* rev. ed. Swani Publishing Co., Box 248, Roscoe, Ill. 61080. Undated.

Colvin, Fred H. *New American machinist's handbook.* New York, N.Y. McGraw-Hill. 1955.

Feirer, John L. *Machine tool metalworking: principles and practices;* 2d ed. New York, N.Y. McGraw-Hill. 1973.

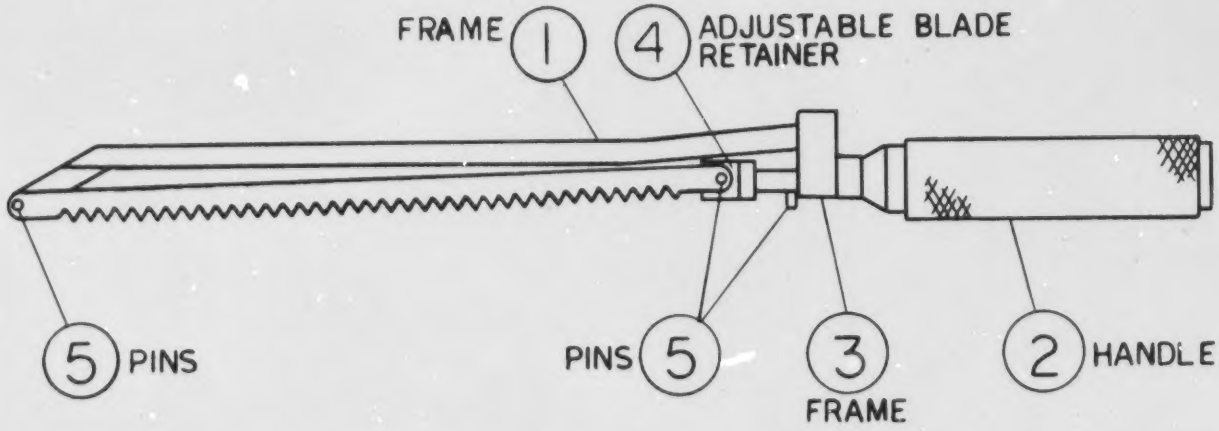
McCarthy, Willard J. & Smith, Robert E. *Machine tool technology;* 3d ed. Bloomington, Ill. McKnight & McKnight. 1968. (Order from Taplinger Publishing Co., 200 Park Ave., S., New York, N.Y. 10003.)

Oberg, Erik & Jones, Franklin D. *Machinery's handbook;* 19th ed. New York, N.Y. Industrial Press. 1971.

Use and care of twist drills. Cleveland Twist Drill Co., 1242 E. 49th St., Cleveland, O. Undated. (Free in limited quantities.)

Walker, John R. *Machining fundamentals.* South Holland, Ill. Goodheart-Wilcox Co. 1973.

Drawings For Shop Projects



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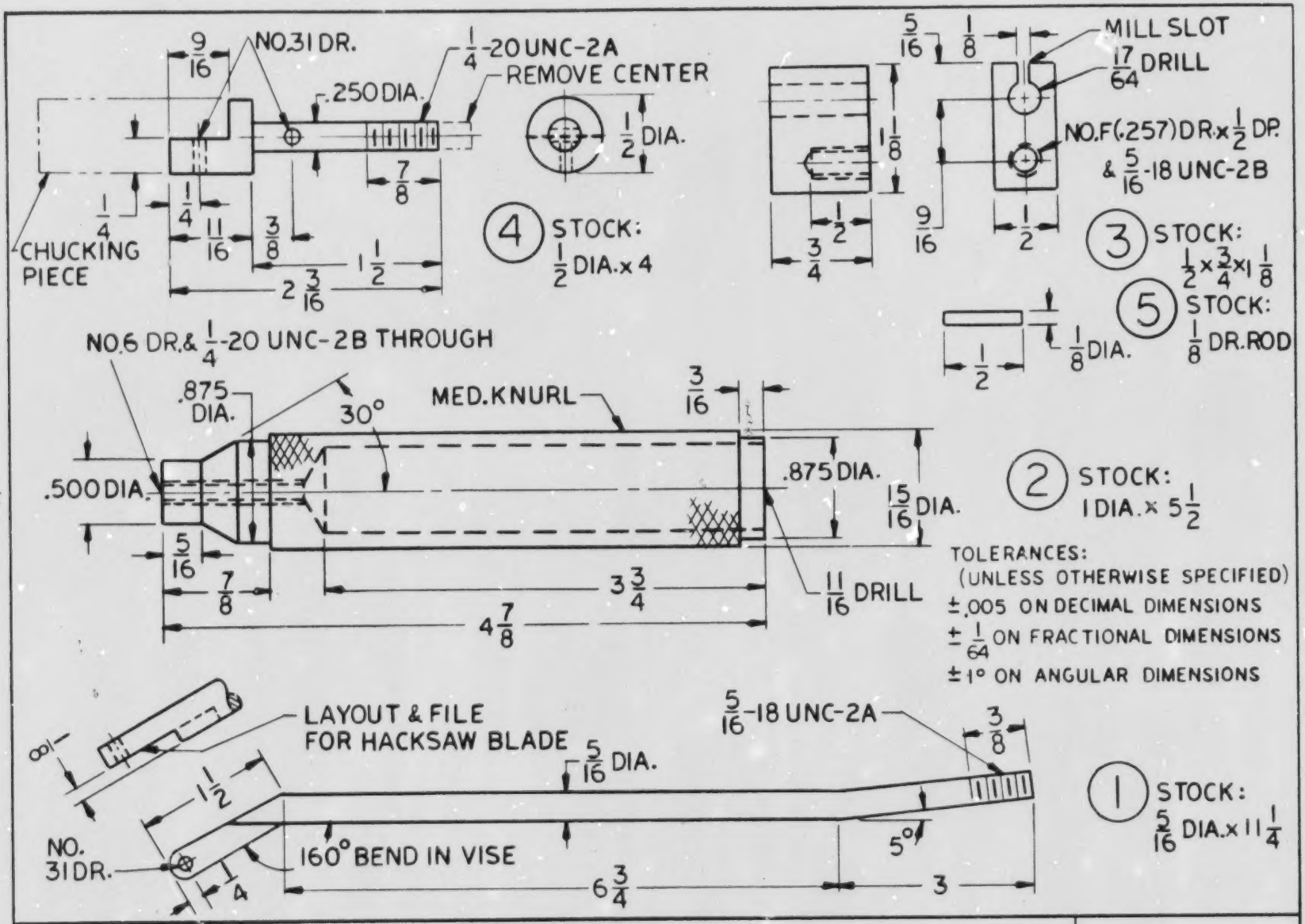
SCALE: ——		DWG. NO. 13



DRAWN BY: E.F.S.	CLOSE QUARTERS HACKSAW DETAILS	
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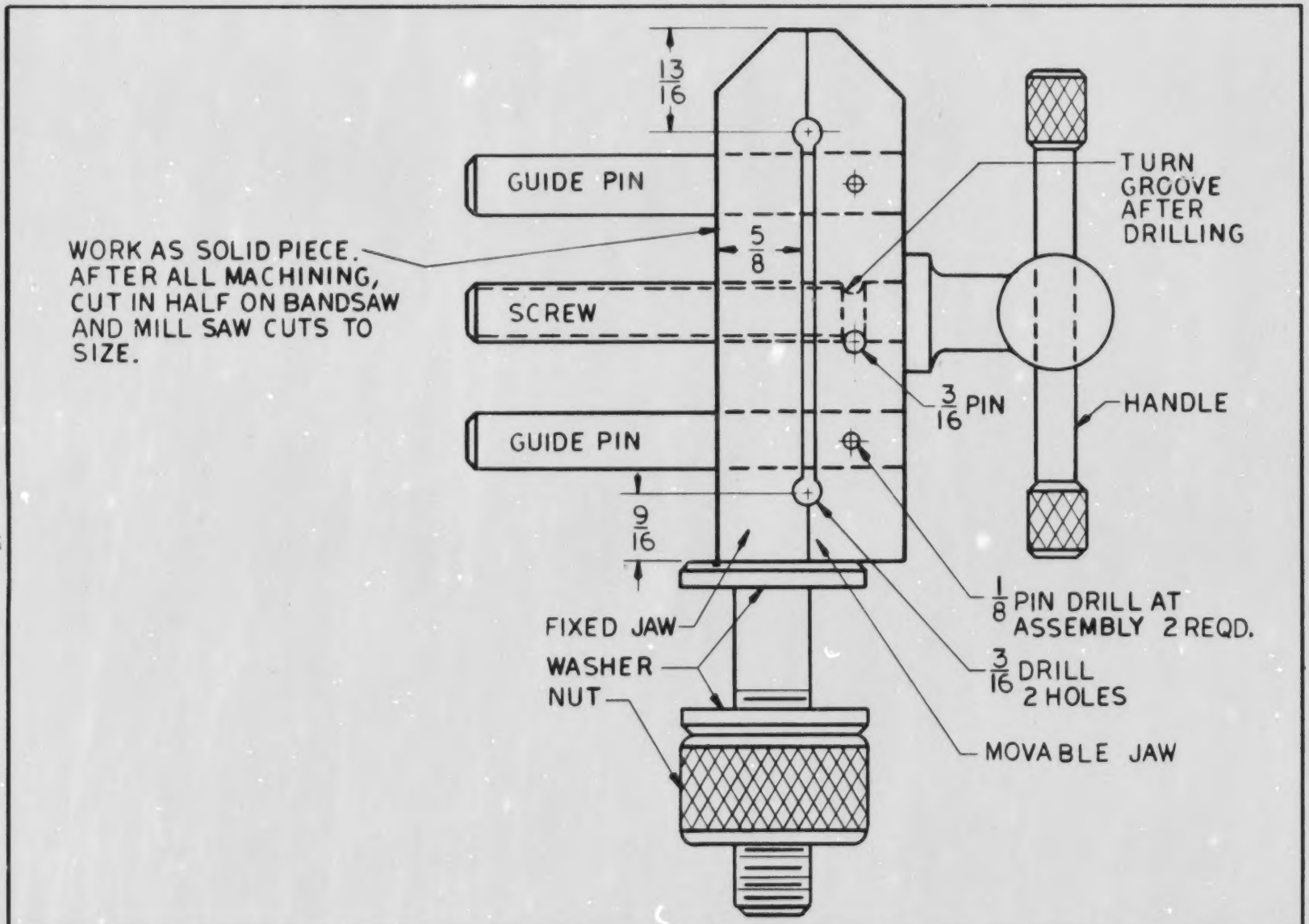
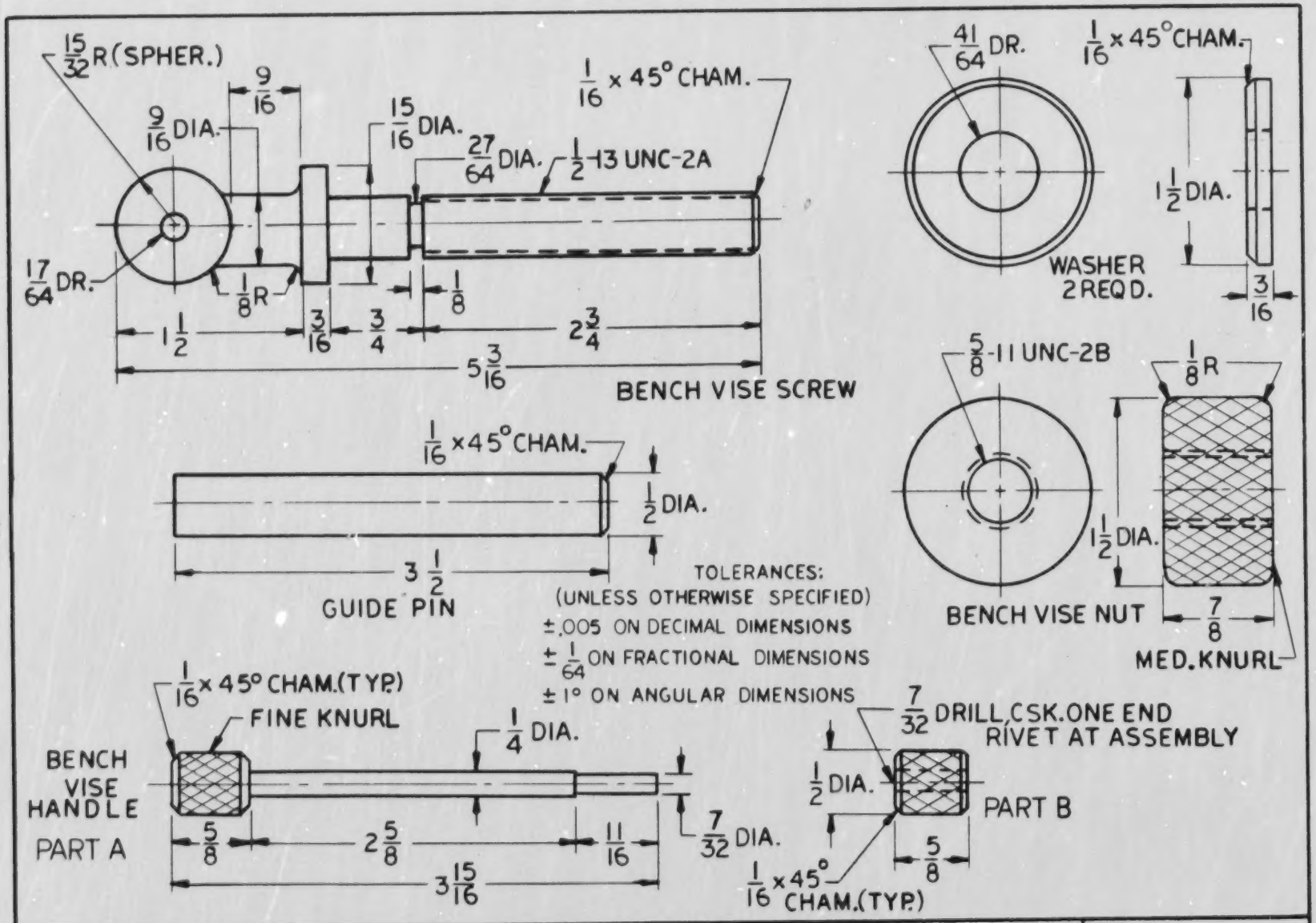
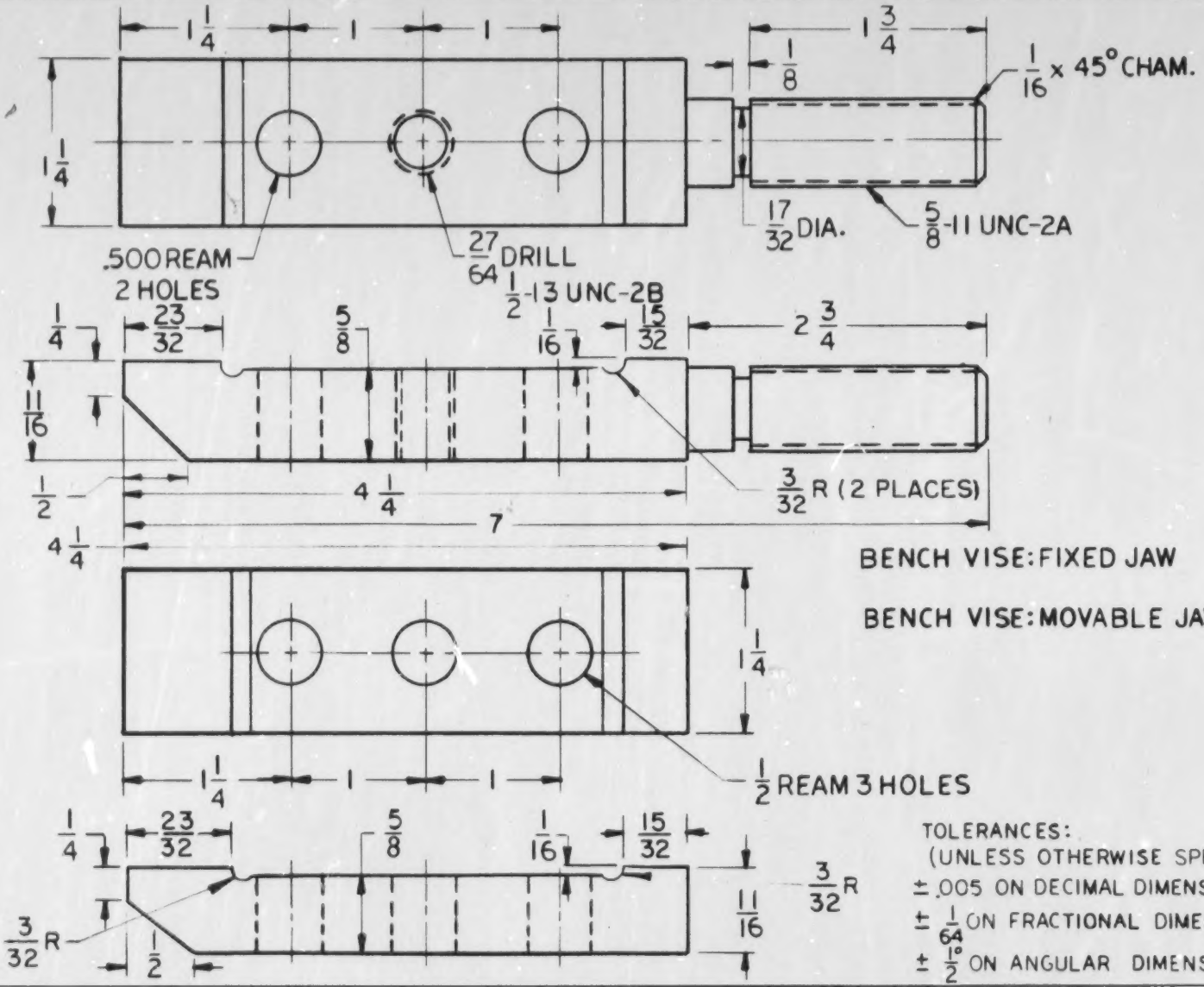


DRAWN BY: E.F.S. SCALE: ——	BENCH VISE ASSEMBLY	DWG. NO. 15

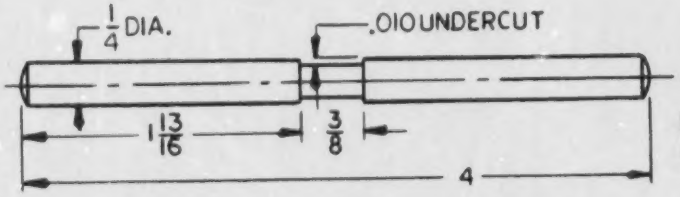


DRAWN BY: E.F.S.	BENCH VISE DETAILS	
SCALE: ——		DWG. NO. 16

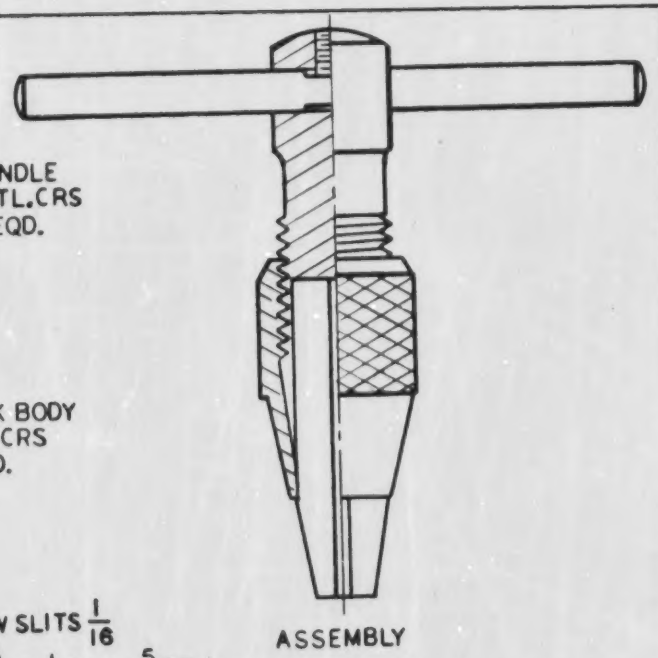


TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
± .005 ON DECIMAL DIMENSIONS
± 1/64 ON FRACTIONAL DIMENSIONS
± 1/2° ON ANGULAR DIMENSIONS

DRAWN BY: V.C.L.	BENCH VISE FIXED AND MOVABLE JAWS	
SCALE: ——		DWG. NO.17



HANDLE
MATL. CRS
1 REQD.



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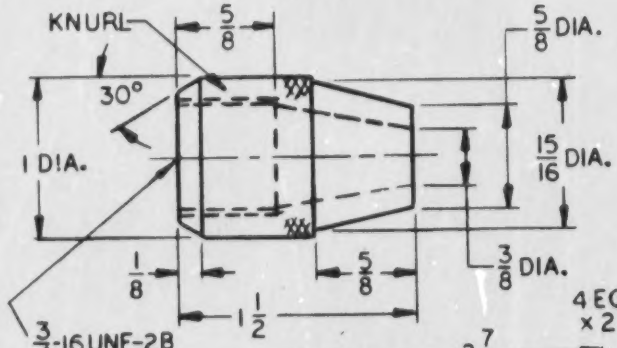
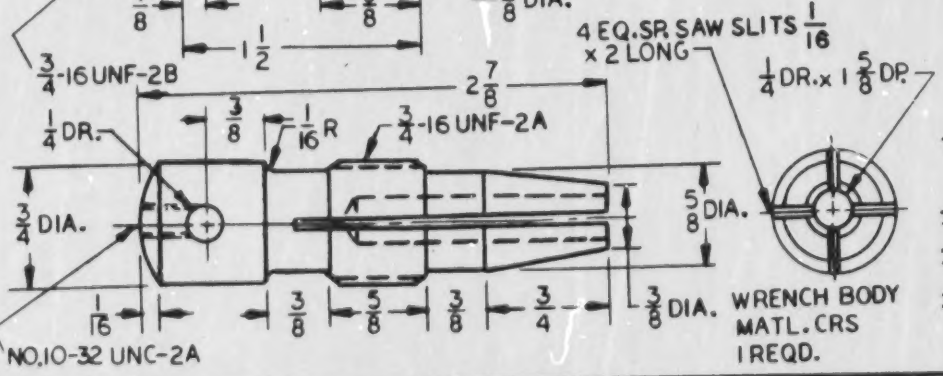


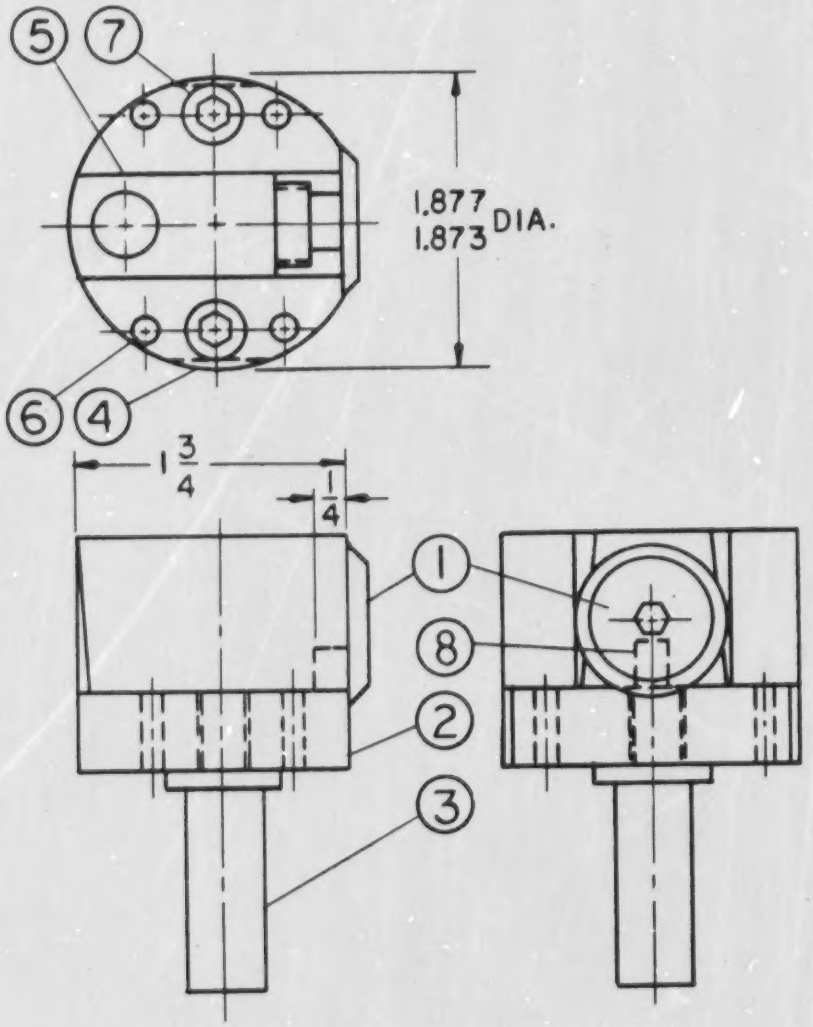
CHUCK BODY
MATL. CRS
1 REQD.



WRENCH BODY
MATL. CRS
1 REQD.

TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
±.005 ON DECIMAL DIMENSIONS
± 1/64 ON FRACTIONAL DIMENSIONS
±1° ON ANGULAR DIMENSIONS

DRAWN BY: E.F.S.	TAP WRENCH	REV. 8/1/72
		DWG. NO. 21

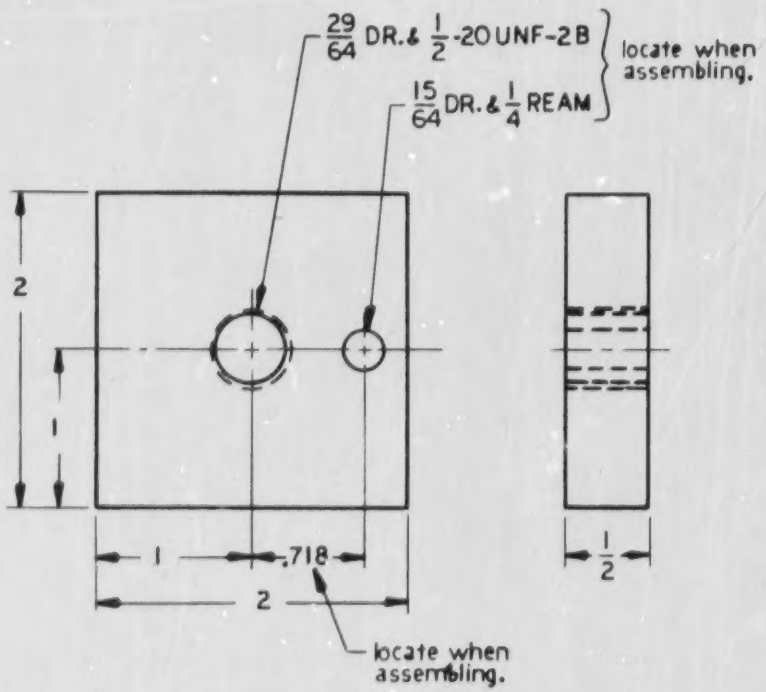


PARTS LIST			
NO.	NAME	MATL.	REQD.
1	GRADUATED DIAL	C R S	1
2	PLATE	C R S	1
3	SHANK	C R S	1
4	DOVETAIL BLOCKS	C R S	2
5	DOVETAIL SLIDE	C R S	1
6	DOWEL PIN $\frac{3}{16}$ DIA. x $1\frac{1}{4}$	C R S	4
7	HEX. HD. CAP SCR. $\frac{5}{16}$-18 UNC	C R S	2
8	STOP PIN	C R S	1

NOTES:

1. PARTS 2 AND 4 ARE MILLING MACHINE PROJECTS.
2. PARTS 6 AND 7 ARE PURCHASED.
3. PARTS 2, 4 AND 5 ARE ASSEMBLED TO A 2" SQ. AND THEN MACHINED ROUND.

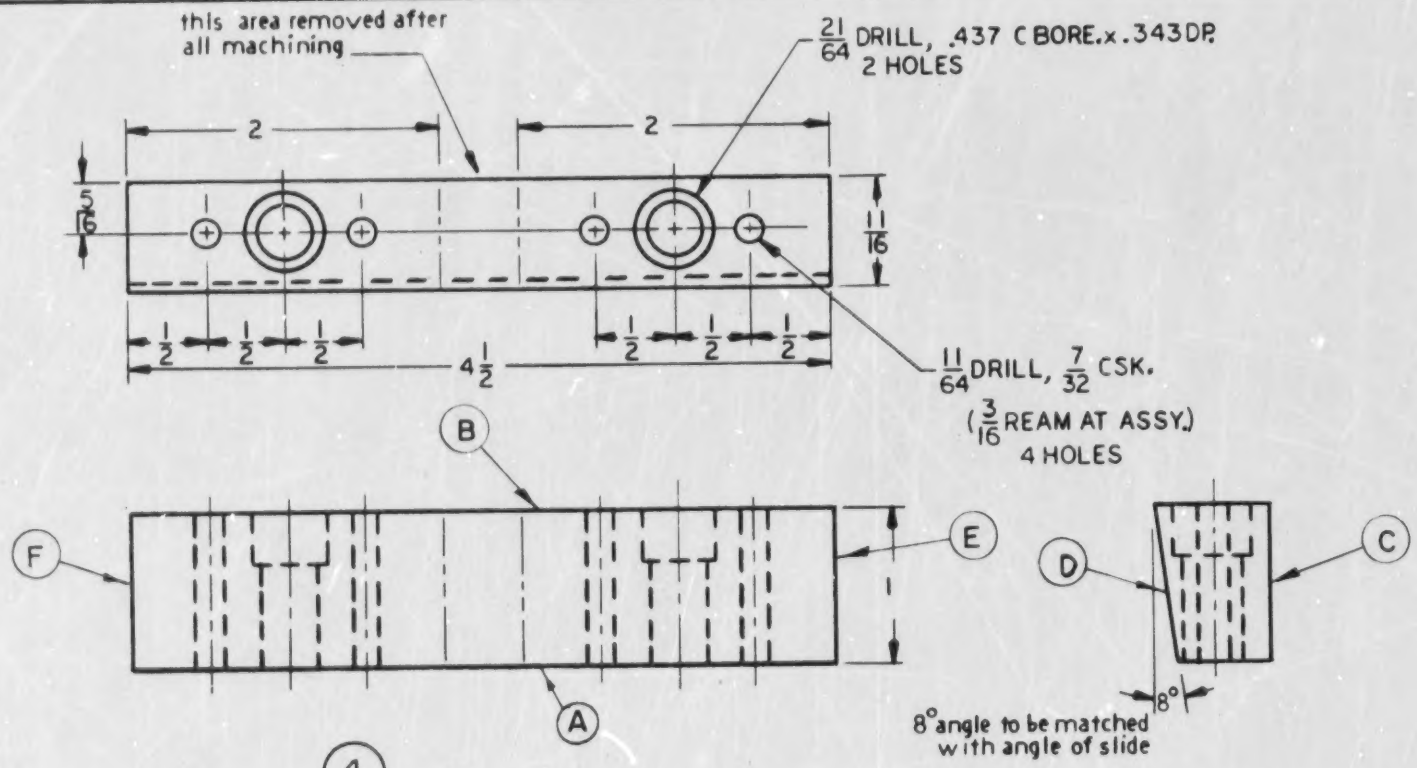
DRAWN BY: E.F.S.	MICROMETER BORING HEAD ASSEMBLY	
SCALE: ——		DWG. NO. 22



(2) MATL. C R S
FAO

TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
± .005 DECIMAL
± 1/64 FRACTIONAL
± 1/2° ANGULAR

DRAW BY: E.F.S.	MICROMETER BORING HEAD	
SCALE: ——	PLATE	DWG. NO. 22.1



4

MATL. CRS (SAE 1020) or PHOSPHOR BRONZE (SAE 64)

FAO

2 REQD.

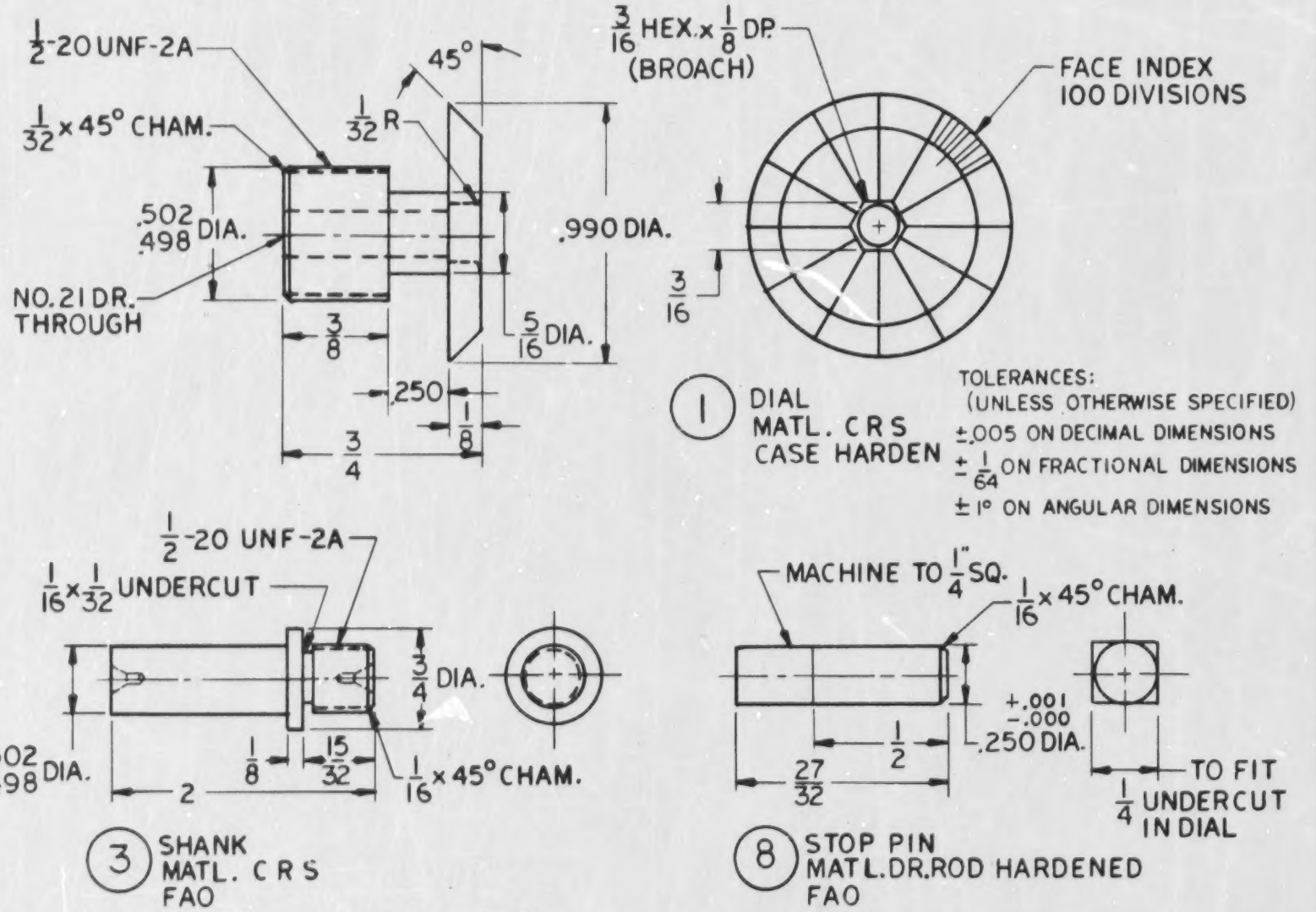
TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)

± .005 DECIMAL

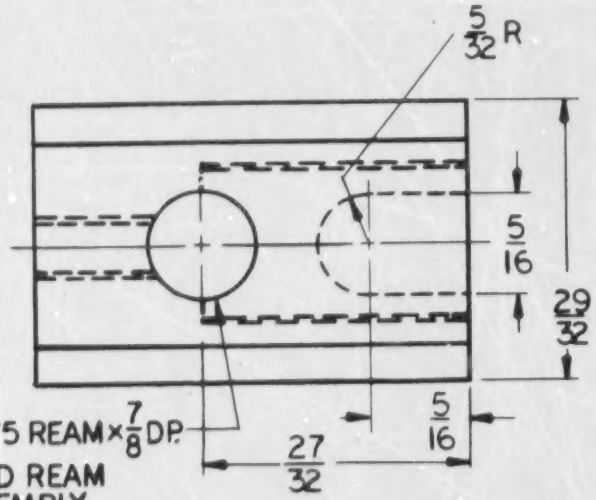
± 1/64 FRACTIONAL

± 1/2° ANGULAR

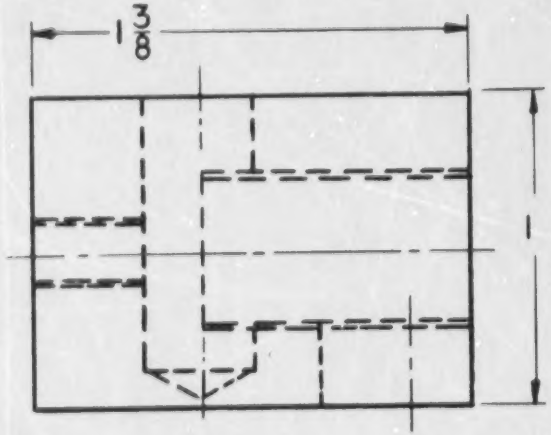
DRAWN BY: E.F.S.	MICROMETER BORING HEAD DOVETAIL BLOCKS	
SCALE: ——		DWG. NO. 22.2

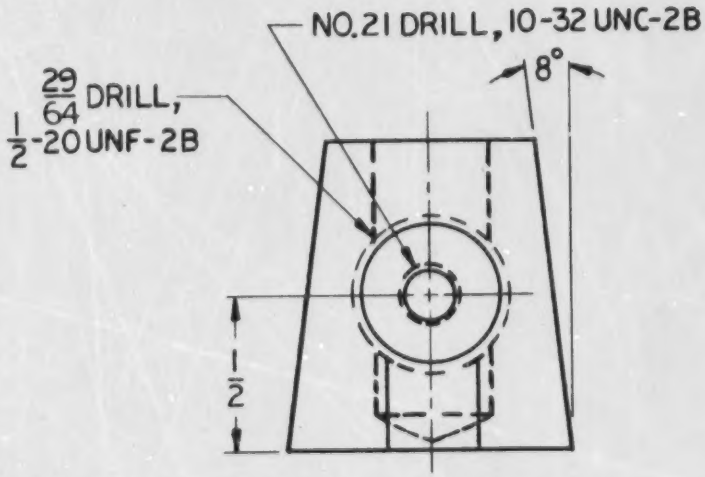


DRAWN BY : E.F.S.	MICROMETER BORING HEAD	
SCALE : ——	DIAL, SHANK, AND STOP PIN	DWG. NO. 23



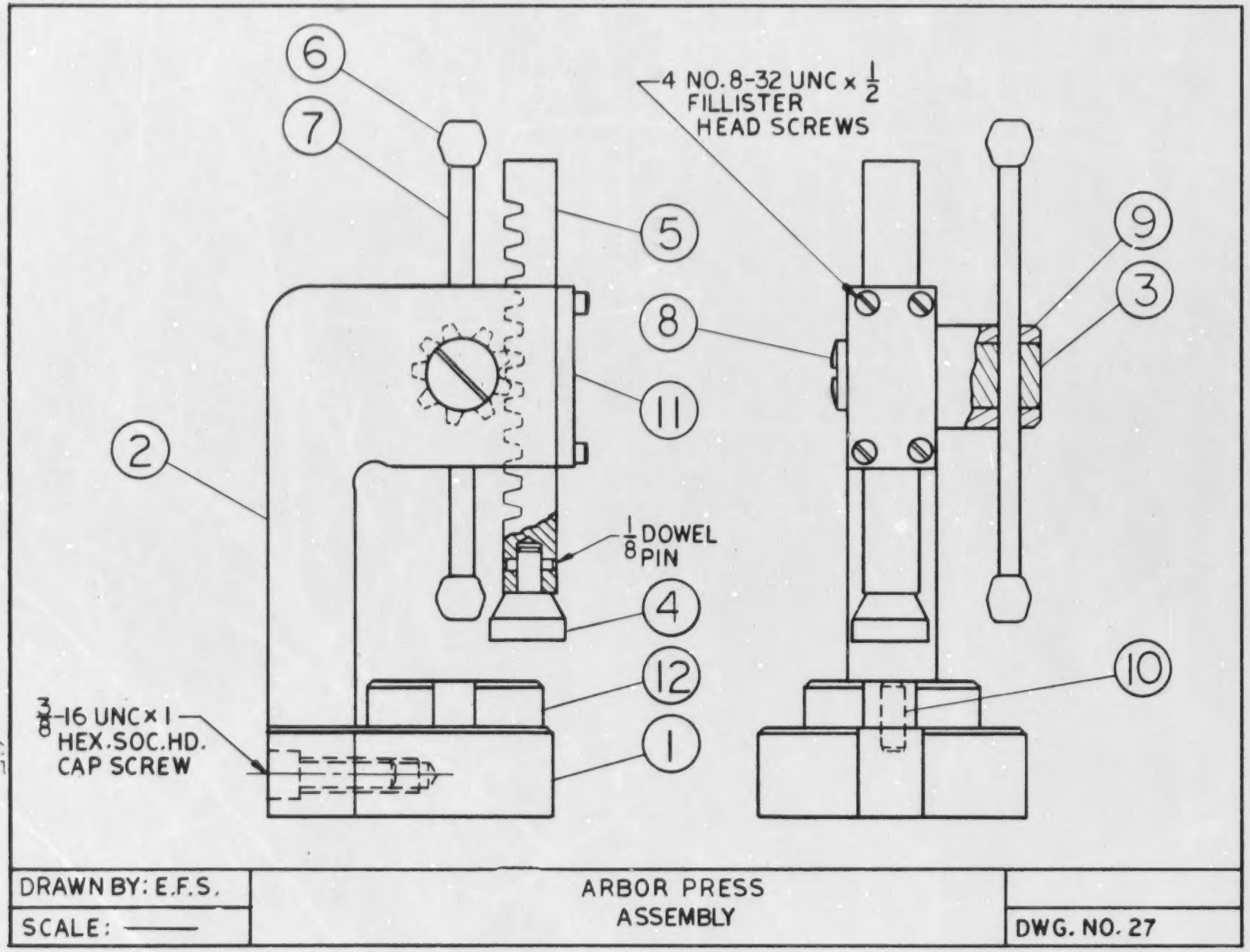
TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
±.005 ON DECIMAL DIMENSIONS
± 1/64 ON FRACTIONAL DIMENSIONS
± 1/2° ON ANGULAR DIMENSIONS



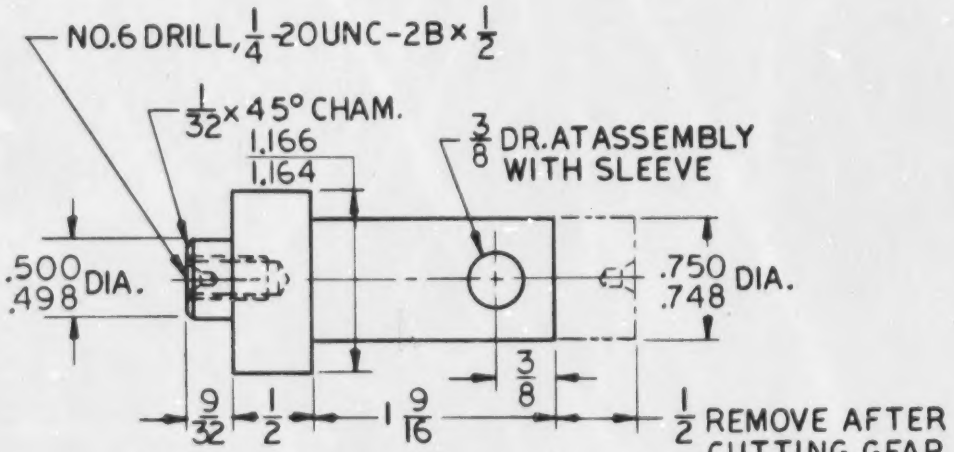


(5) DOVETAIL SLIDE
MATL. CRS
FAO

DRAWN BY: E.F.S.	MICROMETER BORING HEAD	
SCALE: ——	DOVETAIL SLIDE	DWG. NO. 24

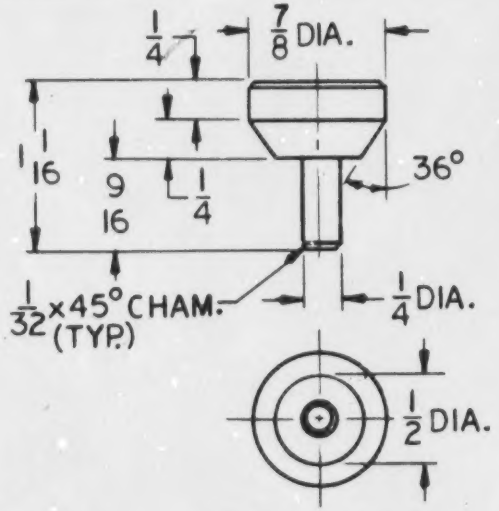


DRAWN BY: E.F.S.	ARBOR PRESS ASSEMBLY	
SCALE: ——		DWG. NO. 27

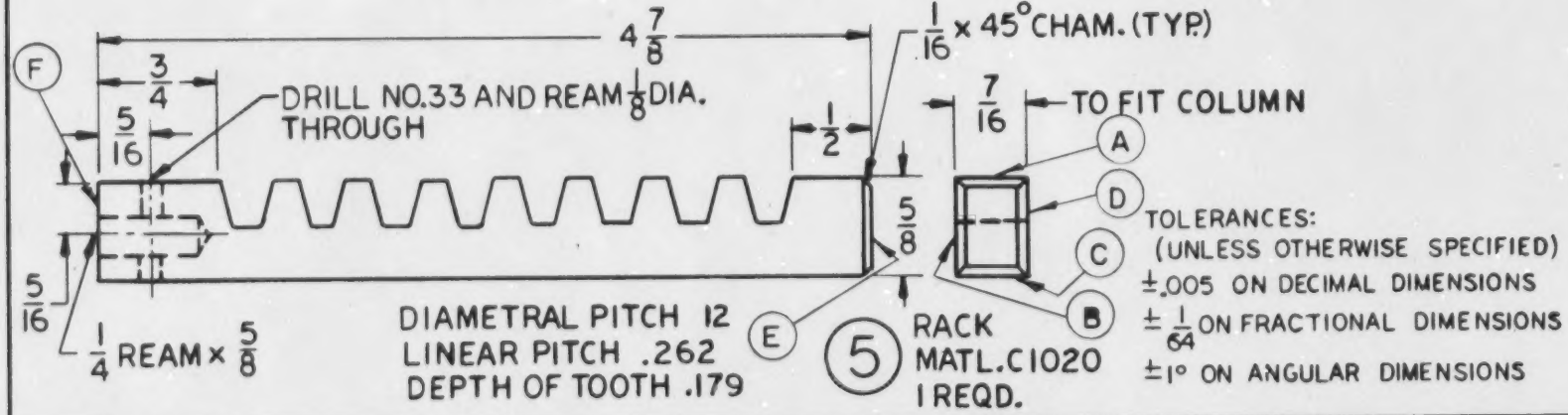


DIAMETRAL PITCH 12
NO. OF TEETH 12

(3) GEAR SHAFT
MATL. C1010
1 REQD.



(4) RACK PAD
MATL. C1020
1 REQD.

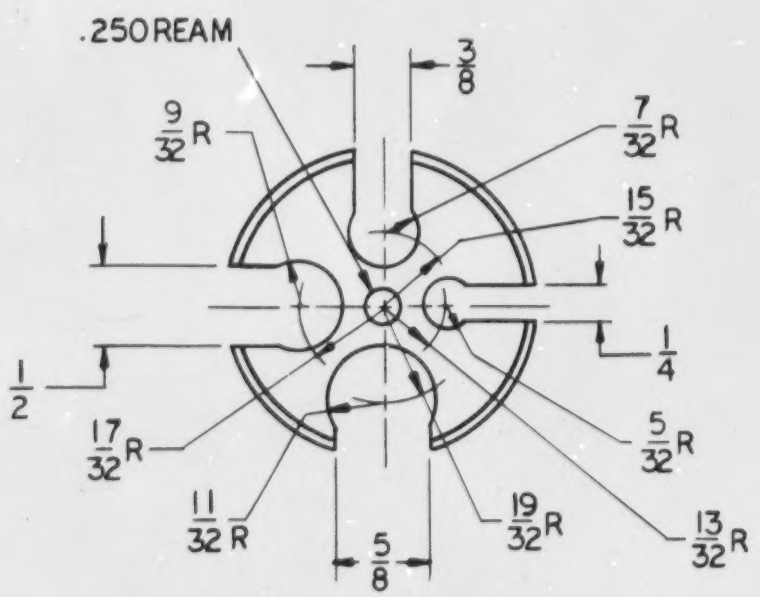


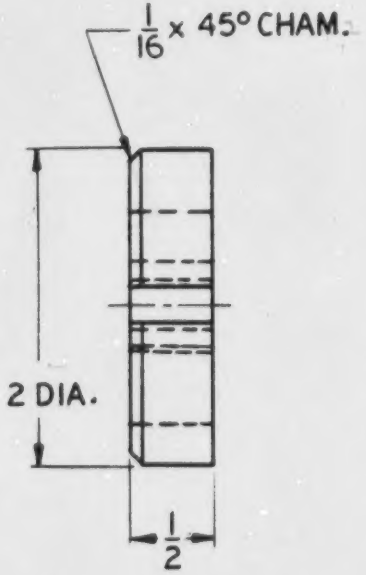
DIAMETRAL PITCH 12
LINEAR PITCH .262
DEPTH OF TOOTH .179

(5) RACK
MATL. C1020
1 REQD.

TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
±.005 ON DECIMAL DIMENSIONS
± 1/64 ON FRACTIONAL DIMENSIONS
±1° ON ANGULAR DIMENSIONS

DRAWN BY: E.F.S.	ARBOR PRESS	
SCALE: ——	GEAR SHAFT, RACK PAD, AND RACK	DWG. NO. 28



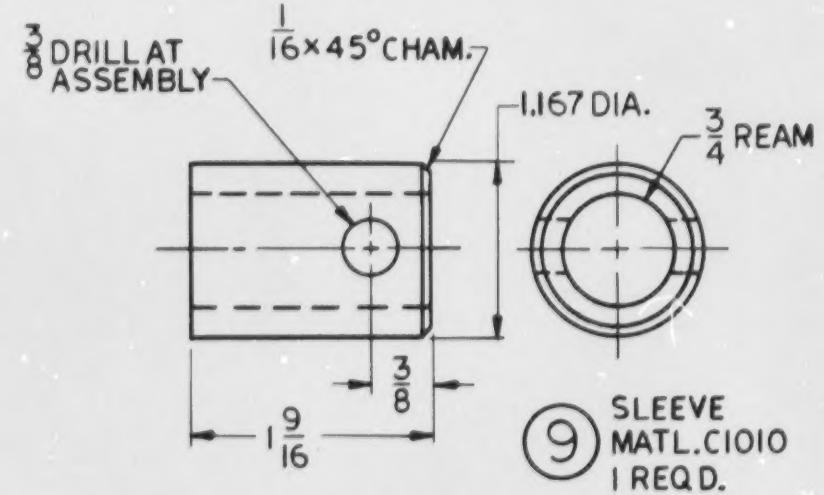


(12) MATL. C1020
1 REQ'D.

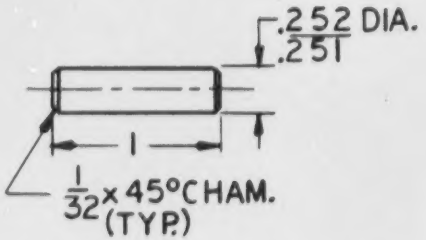
NOTE:
COUNTERSINK ALL HOLES TOP AND BOTTOM 1/32 DEEP BEFORE SLOTTING.

TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
± .005 ON DECIMAL DIMENSIONS
± 1/64 ON FRACTIONAL DIMENSIONS
± 1° ON ANGULAR DIMENSIONS

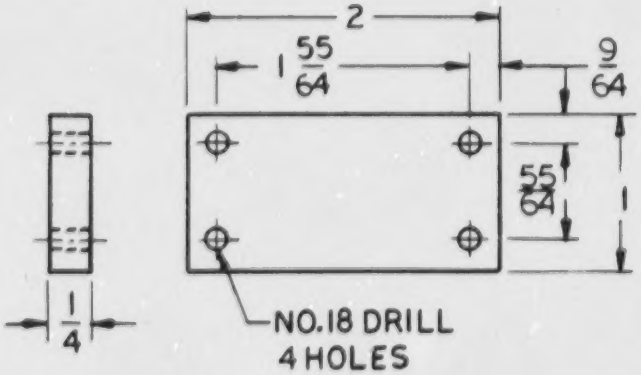
DRAWN BY: E.F.S.	ARBOR PRESS TABLE	
SCALE: ———		DWG. NO. 29



(9) SLEEVE
MATL. C1010
1 REQ D.



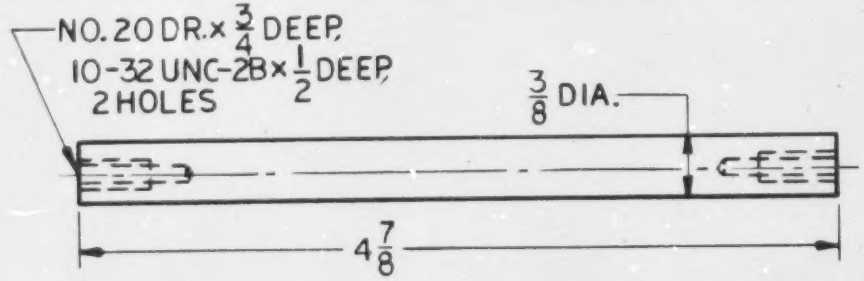
(10) TABLE PIN
MAT L. C1020
1 REQ D.



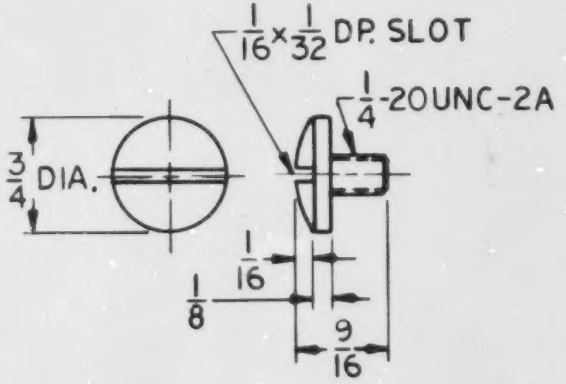
(11) COVER PLATE
MAT L. C1010
1 REQ D.

TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
± .005 ON DECIMAL DIMENSIONS
± 1/64 ON FRACTIONAL DIMENSIONS
± 1° ON ANGULAR DIMENSIONS

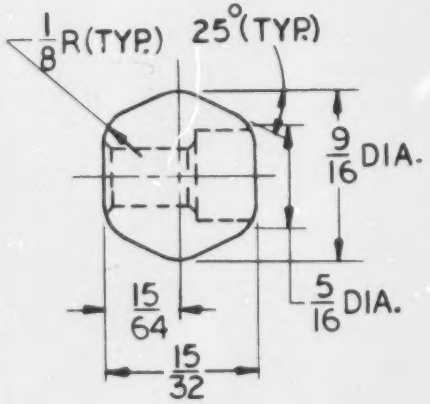
DRAWN BY: E.F.S.	ARBOR PRESS	
SCALE: ——	SLEEVE, TABLE PIN AND COVER PLATE	DWG. NO. 30

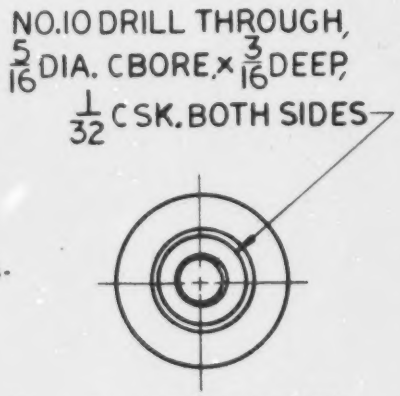


(7) HANDLE
MATL. C1020
1 REQD.



(8) GEAR SHAFT SCREW
MATL. C1020
1 REQD.

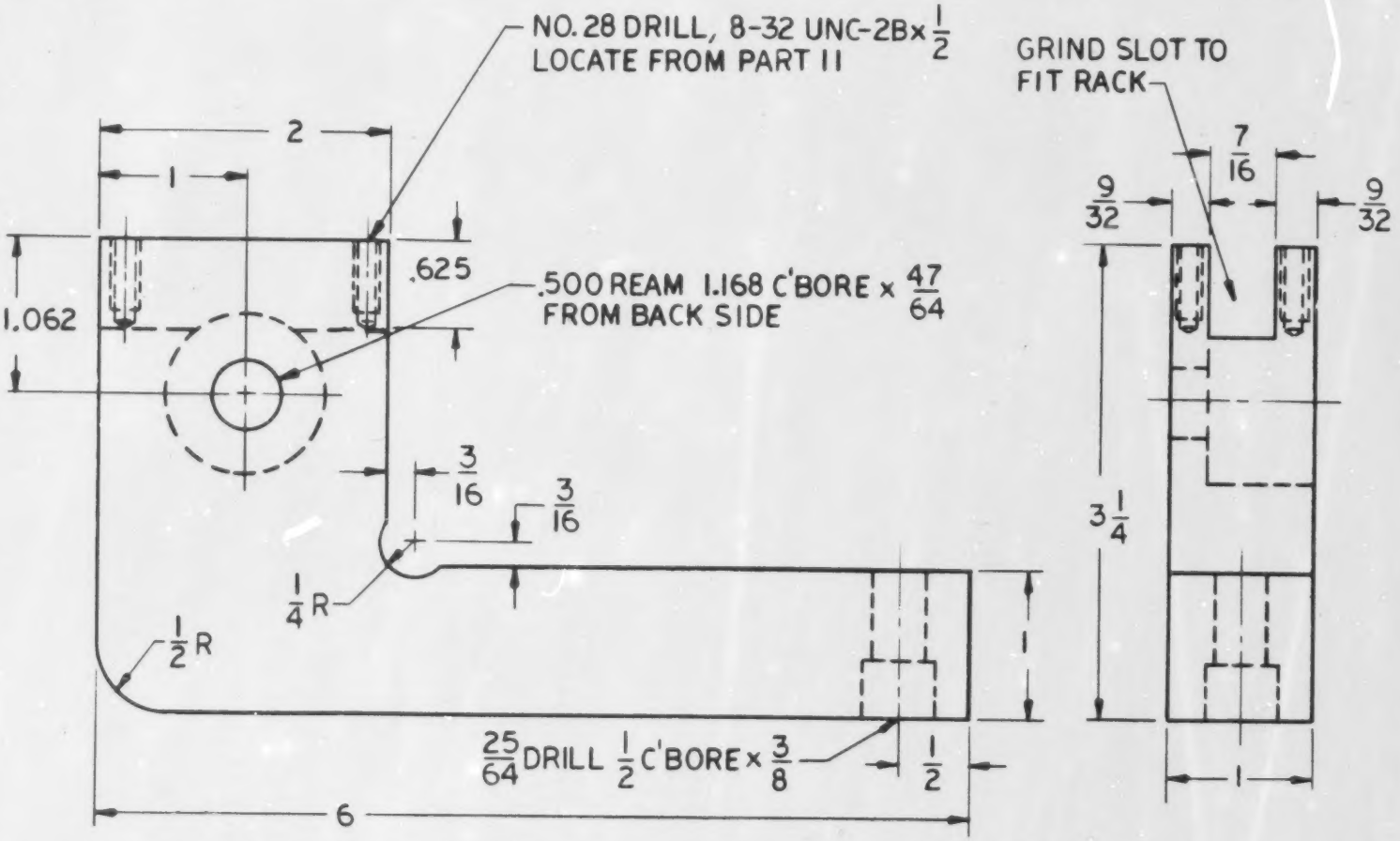




(6) HANDLE END
MATL. CRS
2 REQD.

TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
± .005 ON DECIMAL DIMENSIONS
± 1/64 ON FRACTIONAL DIMENSIONS
± 1° ON ANGULAR DIMENSIONS

DRAWN BY: E.F.S.	ARBOR PRESS HANDLE AND END	
SCALE: —		DWG. NO. 31

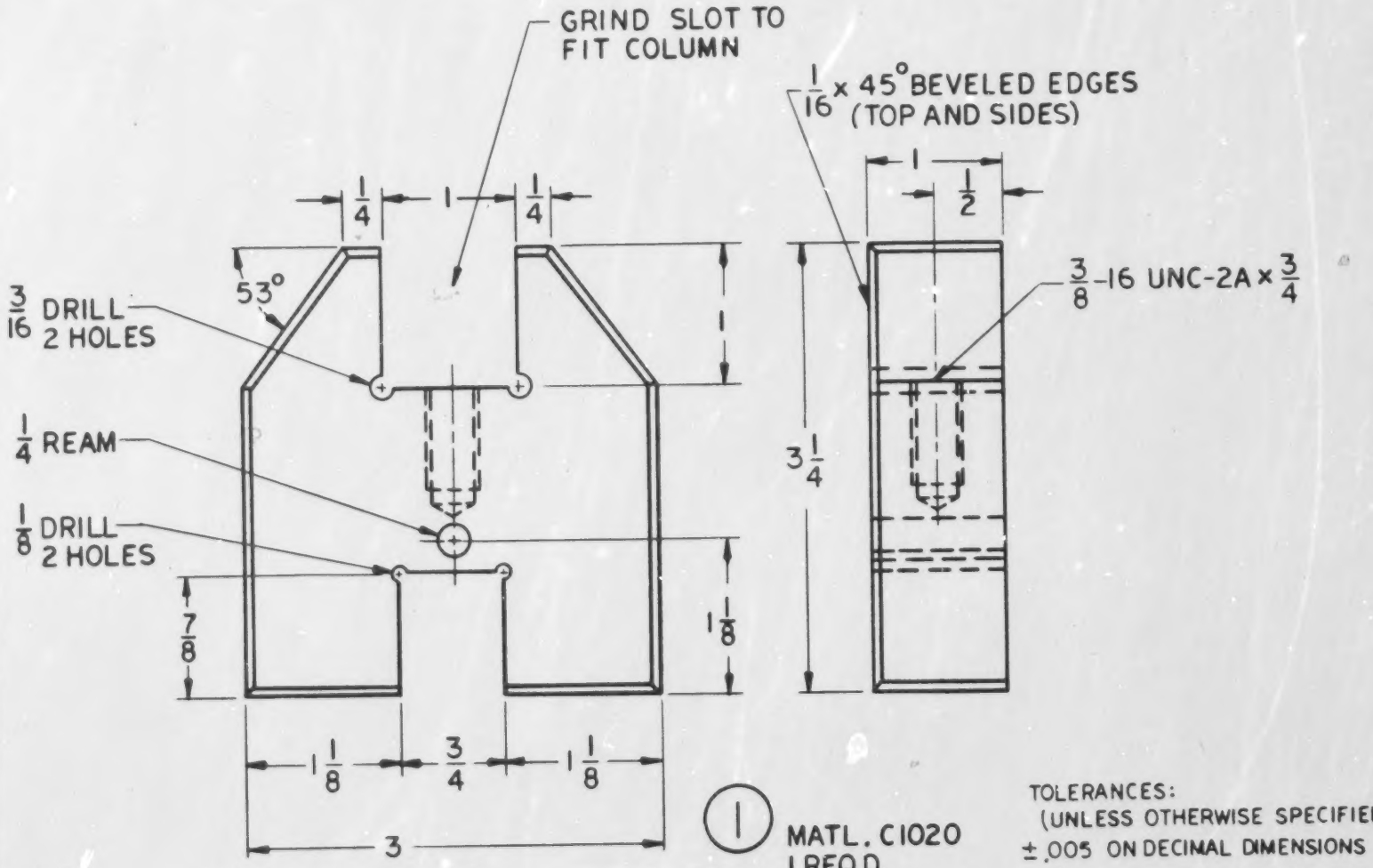


(2)

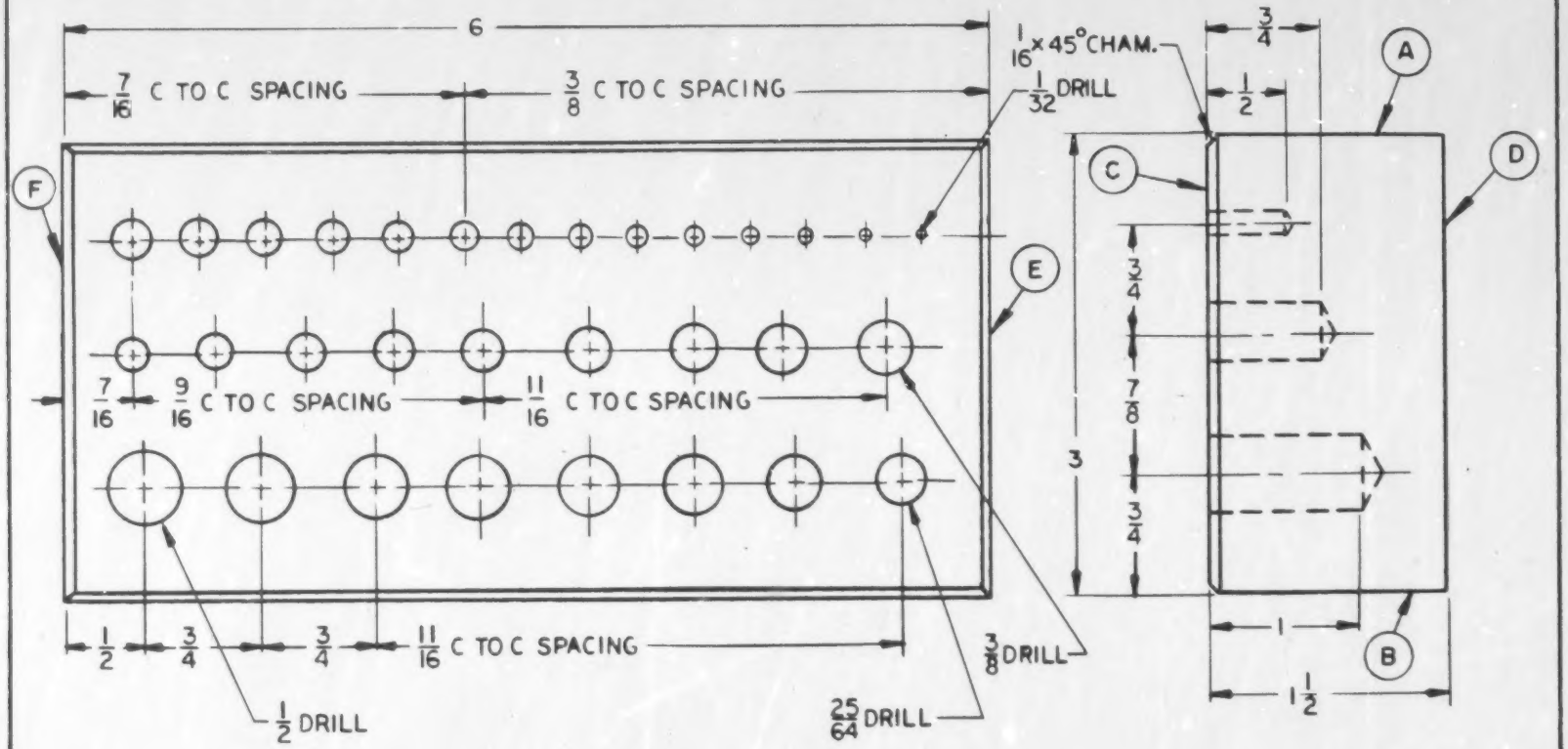
MAT L. C1020
1 REQD.

TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
± .005 ON DECIMAL DIMENSIONS
± 1/64 ON FRACTIONAL DIMENSIONS
± 1° ON ANGULAR DIMENSIONS

DRAWN BY: E.F.S.	ARBOR PRESS COLUMN	
SCALE: ——		DWG. NO. 32



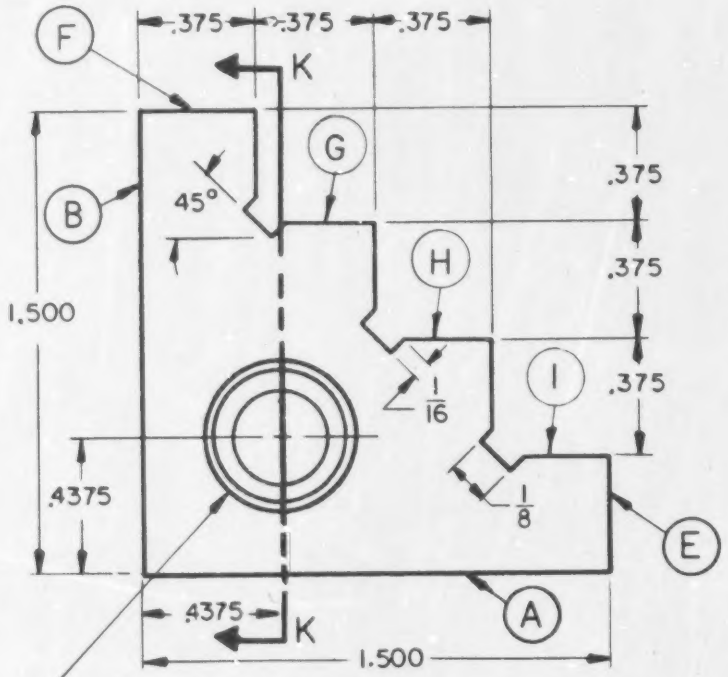
DRAWN BY: E.F.S.	ARBOR PRESS BASE	
SCALE: ——		DWG. NO. 33

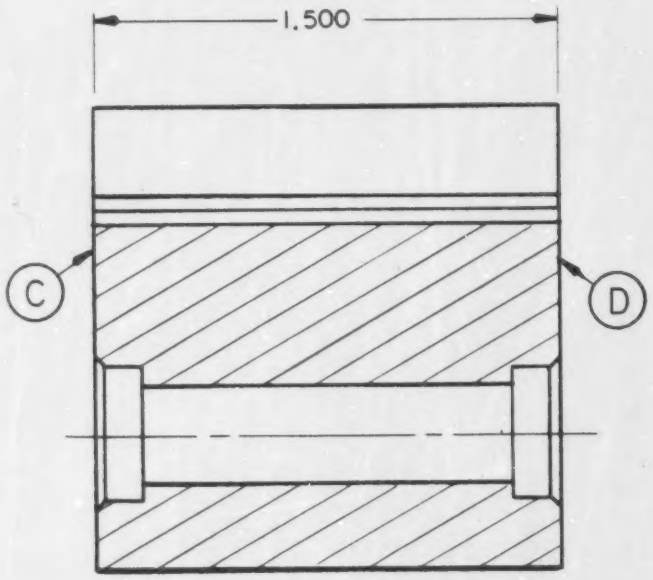


NOTES:
MATL. CAST ALUM.
HOLES GO FROM 1/32 TO 1/2 BY 64 ths
FAO

TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
± .005 DECIMAL
± 1/64 FRACTIONAL
± 1/2° ANGULAR

DRAWN BY: E.F.S.	DRILL STAND	
SCALE: ——		DWG. NO. 42





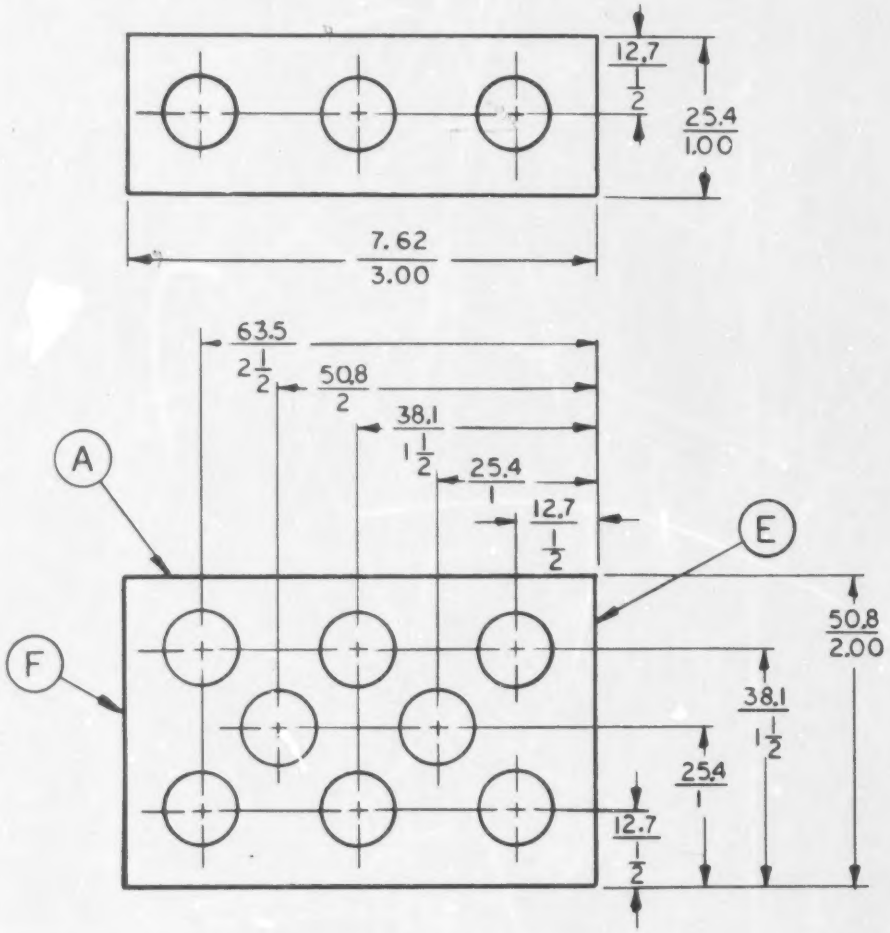
SECTION K-K

5/16 DR. THROUGH, 7/16 CBORE x 5/16 DP. & CSINK. 1/16 DP. BOTH SIDES.

NOTES:
MATL. TOOL STEEL
GRIND ALL FLAT SURFACES.
LEAVE .015 ON EACH SURFACE FOR GRINDING.
HEAT TREAT TO 60C ROCKWELL.

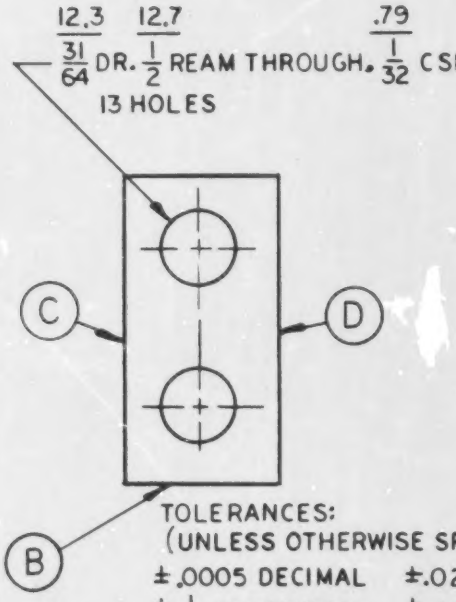
TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
± .0005 DECIMAL
± 1/64 FRACTIONAL
± 1/2° ANGULAR

DRAWN BY: E.F.S.	PRECISION STEP BLOCK	
SCALE: ——		DWG. NO. 44



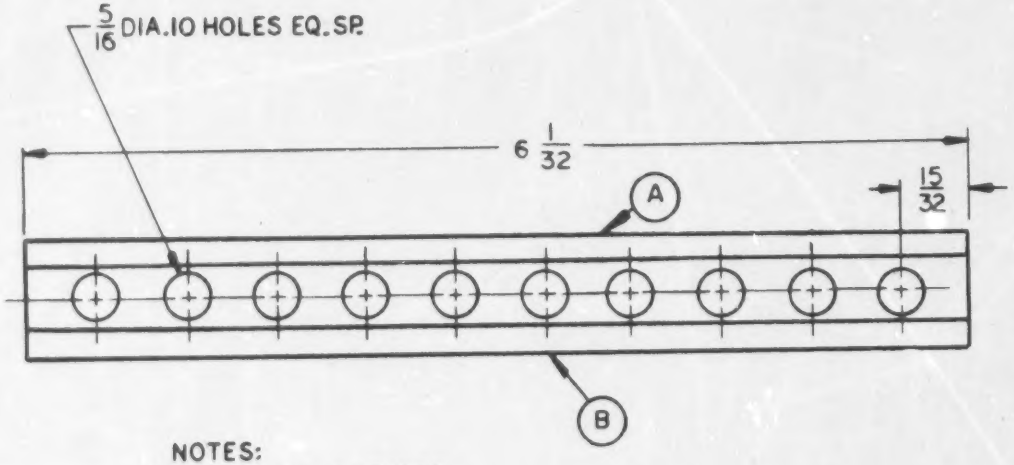
MILLIMETER
INCH

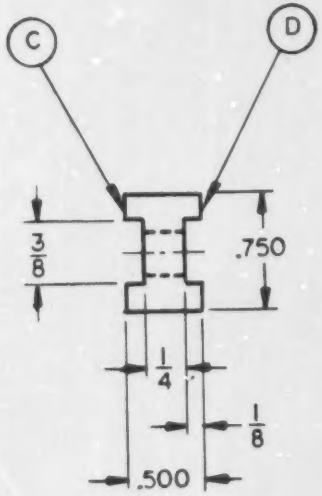
NOTES:
MATL. SAE 1020
CASE HARDEN.
BREAK ALL SHARP CORNERS.
2 REQD.



TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
±.0005 DECIMAL ±.02 MM.
± 1/64 FRACTIONAL ±.4 MM.

DRAWN BY: E.F.S. SCALE: ——	1-2-3 BLOCK (DUAL DIMENSIONING)	DWG. NO. 45.1

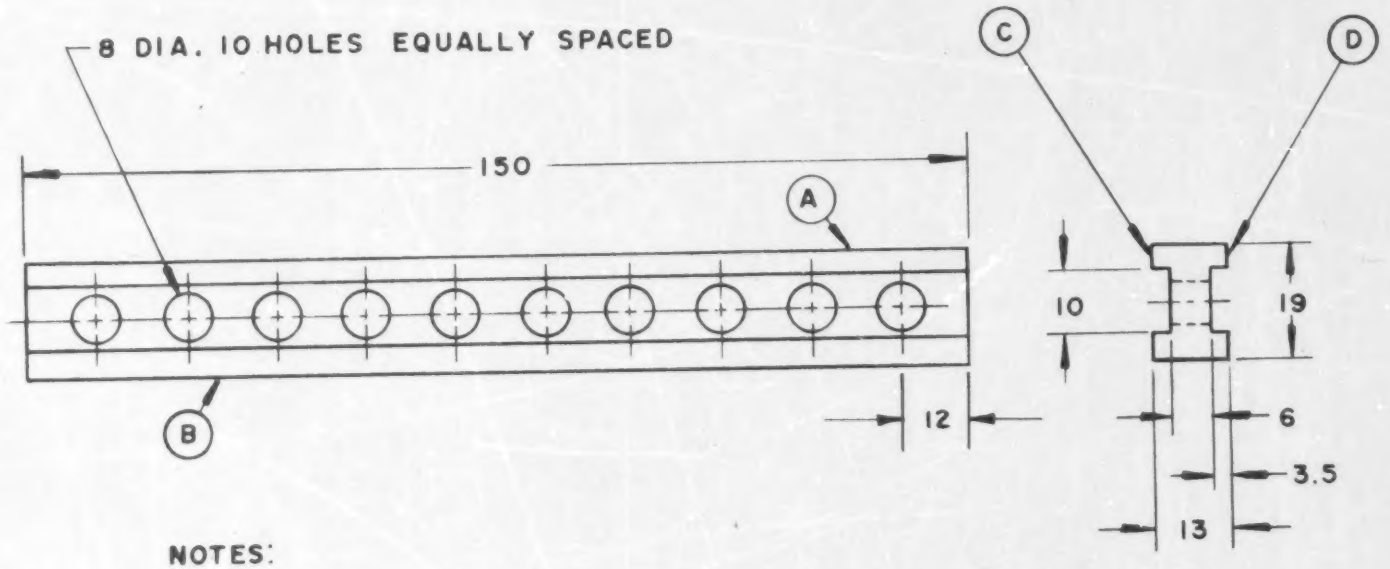




NOTES:
MATL. C.R.S SAE 1020
BREAK ALL SHARP EDGES.
HARDEN AND TEMPER, FINISH GRIND TO 16 MICROINCHES.
2 REQD. (MATCHED IN PAIRS)
LEAVE .030 FOR GRINDING ON .500 AND .750 DIMENSIONS.

TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
±.005 DECIMAL
±1/64 FRACTIONAL
±1/2° ANGULAR

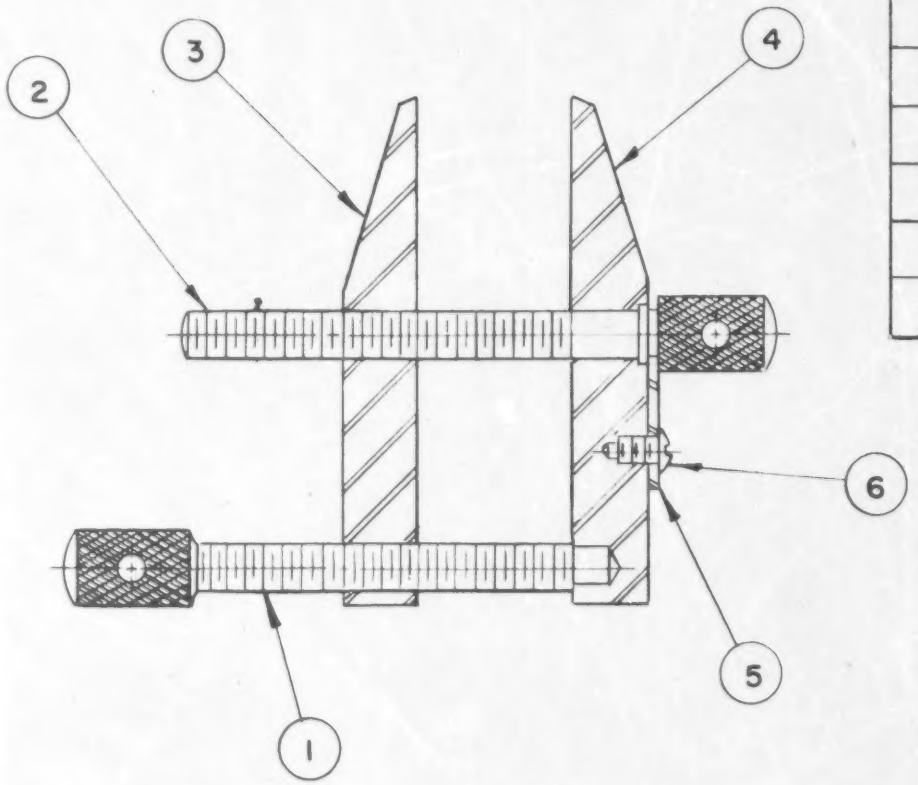
DRAWN BY: E.F.S.	PARALLELS (INCHES)	
SCALE: ——		DWG. NO. 50 A



NOTES:
MATL. CRS SAE 1020
BREAK ALL SHARP EDGES.
HARDEN AND TEMPER, FINISH GRIND TO 16 MICROINCHES.
2 REQD. (MATCHED IN PAIRS)

TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
± 0.4 MILLIMETER

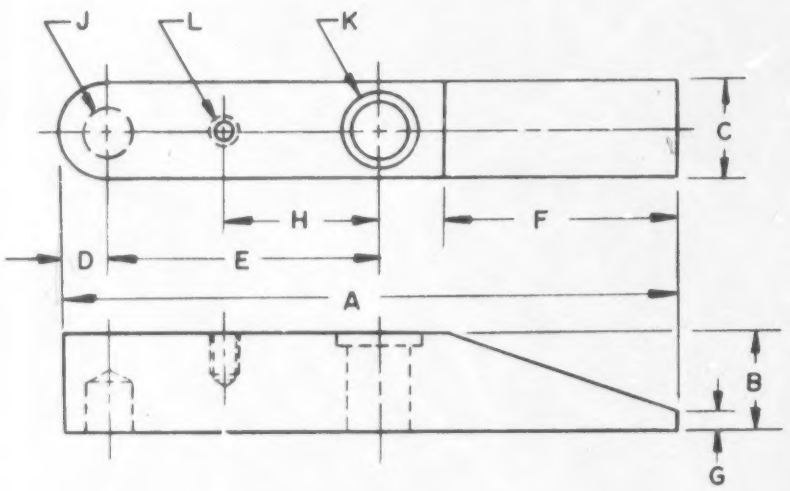
DRAWN BY: V.C.L.	PARALLELS (MILLIMETERS)	
SCALE: ——		DWG.NO. 50 B

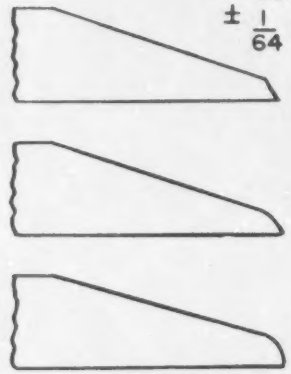


ITEM	PART NAME	MATL.
1	CLAMPING SCR	CRS
2	ADJUSTING SCR.	CRS
3	THREADED JAW	CRS
4	LOOSE JAW	CRS
5	STRAIGHT CLIP	CRS
6	RD. HD. MACH. SCR 8-32 X $\frac{1}{4}$	COMM.

DRAWN BY: V.C.L.	PARALLEL CLAMP ASSEMBLY	DWG. NO. 56

TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
± .003 DECIMAL
± 1/64 FRACTIONAL

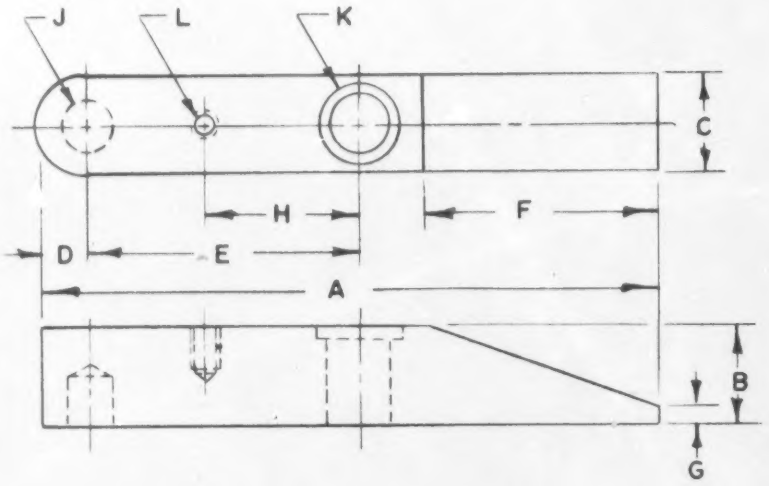




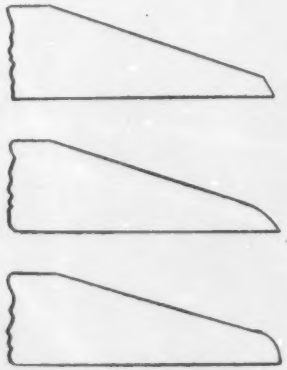
MATERIAL: C R S
CASE HARDEN

REF. NO.	FINISHED DIMENSIONS (INCHES)										
	A	B	C	D	E	F	G	H	J	K, CBORE.	L
1	$2\frac{1}{8}$	$\frac{5}{16}$	$\frac{5}{16}$	$\frac{5}{32}$	1	$\frac{3}{4}$	$\frac{1}{16}$	$\frac{1}{2}$	$\frac{1}{8}$ DIA x $\frac{5}{32}$ DEEP	$\frac{7}{32}$ DIA. $\frac{1}{4}$ x $\frac{3}{32}$ DEEP	6-32 UNC x $\frac{3}{16}$ DP.
2	$2\frac{3}{4}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{16}$	$1\frac{1}{4}$	1	$\frac{3}{32}$	$\frac{3}{4}$	$\frac{3}{16}$ DIA x $\frac{3}{16}$ DEEP	$\frac{9}{32}$ DIA. $\frac{5}{16}$ x $\frac{3}{32}$ DEEP	6-32 UNC x $\frac{3}{16}$ DP.
3	$3\frac{3}{8}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{1}{4}$	$\frac{1}{8}$	$\frac{3}{4}$	$\frac{1}{4}$ DIA x $\frac{1}{4}$ DEEP	$\frac{11}{32}$ DIA. $\frac{7}{16}$ x $\frac{3}{32}$ DEEP	8-32 UNC x $\frac{5}{16}$ DP.
4	4	$\frac{5}{8}$	$\frac{5}{8}$	$\frac{5}{16}$	$1\frac{3}{4}$	$1\frac{1}{2}$	$\frac{5}{32}$	1	$\frac{5}{16}$ DIA x $\frac{5}{16}$ DEEP	$\frac{13}{32}$ DIA. $\frac{9}{16}$ x $\frac{3}{32}$ DEEP	8-32 UNC x $\frac{5}{16}$ DP.
5	5	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{8}$	$2\frac{3}{8}$	$1\frac{3}{4}$	$\frac{3}{16}$	1	$\frac{3}{8}$ DIA x $\frac{3}{8}$ DEEP	$\frac{17}{32}$ DIA. $\frac{11}{16}$ x $\frac{3}{32}$ DEEP	8-32 UNC x $\frac{5}{16}$ DP.

DRAWN BY: V.C.L.	PARALLEL CLAMP LOOSE JAW (INCHES)	DWG. NO. 57 A



MATERIAL: CRS
CASE HARDEN



ALTERNATE JAW DESIGNS

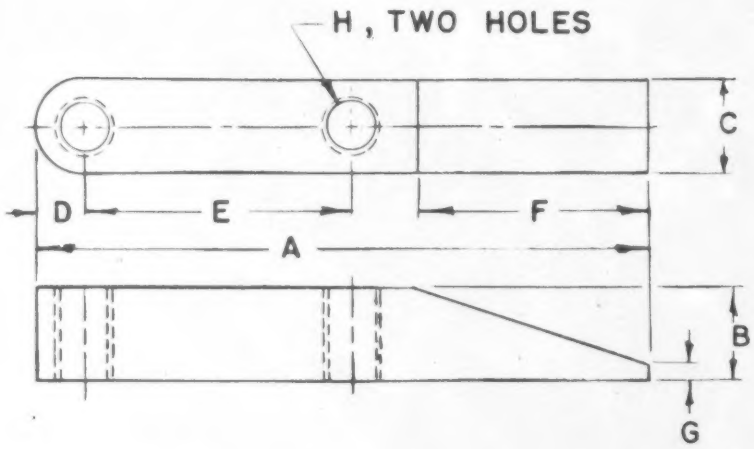
REF. NO.	FINISHED DIMENSIONS										
	MILLIMETERS										INCHES
	A	B	C	D	E	F	G	H	J	K, CBORE.	L
1	54	8	8	4.0	25.4	19.1	1.6	12.7	3.18D. X 3.97 DP.	5.56D. 6.35 X 2.38DP.	6-32 UNC x $\frac{3}{16}$ DP.
2	69.9	9.5	9.6	4.8	31.8	25.4	2.4	19.1	4.76D. X 4.76 DP.	7.15D. 7.94 X 2.38DP.	6-32 UNC x $\frac{3}{16}$ DP.
3	85.7	13	12.8	6.4	38.1	31.8	3.2	19.1	6.35D. X 6.35 DP.	8.73D. 11.11 X 2.38DP.	8-32 UNC x $\frac{5}{16}$ DP.
4	101.6	16	15.8	7.9	44.5	38.1	4.0	25.4	7.94D. X 7.94 DP.	10.32D. 14.29 X 2.38DP.	8-32 UNC x $\frac{5}{16}$ DP.
5	127	19	19	9.5	60.3	44.5	4.8	25.4	9.53D. X 9.53 DP.	13.50D. 17.46 X 2.38DP.	8-32 UNC x $\frac{5}{16}$ DP.

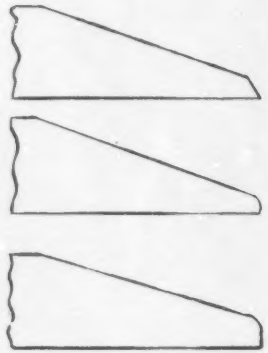
TOLERANCES: UNLESS OTHERWISE SPECIFIED ±0.4MM.
FRACTIONAL: $\pm\frac{1}{64}$

DRAWN BY: V.C.L

PARALLEL CLAMP
LOOSE JAW (MILLIMETERS)

DWG. NO. 57B





ALTERNATE JAW DESIGNS

REF. NO.	FINISHED DIMENSIONS (INCHES)							
	A	B	C	D	E	F	G	H
1	$2\frac{1}{8}$	$\frac{5}{16}$	$\frac{5}{16}$	$\frac{5}{32}$	1	$\frac{3}{4}$	$\frac{1}{16}$	10-24UNC-2
2	$2\frac{3}{4}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{16}$	$1\frac{1}{4}$	1	$\frac{3}{32}$	$\frac{1}{4}$-20UNC-2
3	$3\frac{3}{8}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{1}{4}$	$\frac{1}{8}$	$\frac{5}{16}$-18UNC-2
4	4	$\frac{5}{8}$	$\frac{5}{8}$	$\frac{5}{16}$	$1\frac{3}{4}$	$1\frac{1}{2}$	$\frac{5}{32}$	$\frac{3}{8}$-16UNC-2
5	5	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{8}$	$2\frac{3}{8}$	$1\frac{3}{4}$	$\frac{3}{16}$	$\frac{1}{2}$-13UNC-2

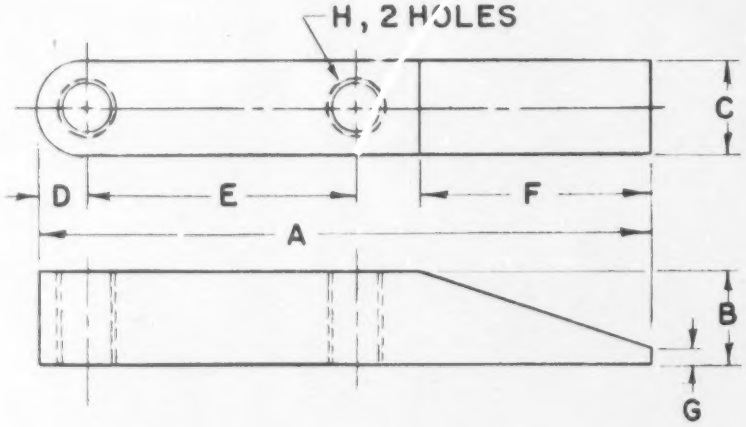
TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
$\pm$.003 DECIMAL
$\pm \frac{1}{64}$ FRACTIONAL

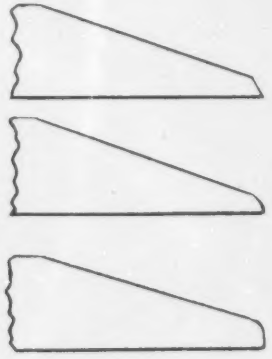
MATERIAL: CRS
CASE HARDEN

DRAWN BY: V.C.L.

PARALLEL CLAMP
THREADED JAW (INCHES)

DWG. NO. 58A





ALTERNATE JAW DESIGNS

REF. NO.	FINISHED DIMENSIONS							
	MILLIMETERS							INCHES
	A	B	C	D	E	F	G	H
1	54	8.0	8.0	4.0	25.4	19.1	1.6	#10-24 UNC-2
2	69.9	9.5	9.6	4.8	31.8	25.4	2.4	$\frac{1}{4}$-20 UNC-2
3	85.7	13.0	12.8	6.4	38.1	31.8	3.2	$\frac{5}{16}$-18 UNC-2
4	101.6	16.0	15.8	7.9	44.5	38.1	4.0	$\frac{3}{8}$-16 UNC-2
5	127.0	19.0	19.0	9.5	60.3	44.5	4.8	$\frac{1}{2}$-13 UNC-2

MATERIAL. CRS

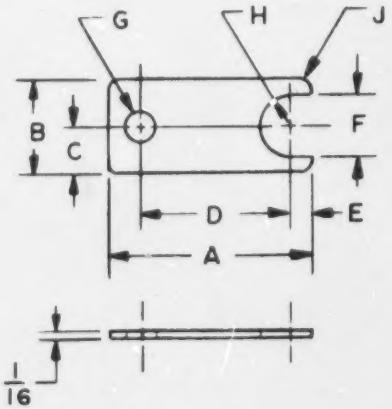
CASE HARDEN

TOLERANCES: (UNLESS OTHERWISE SPECIFIED) $\pm$ 0.4 MM.

DRAWN BY: V.C.L.

PARALLEL CLAMP
THREADED JAW (MILLIMETERS)

DWG. NO. 58B

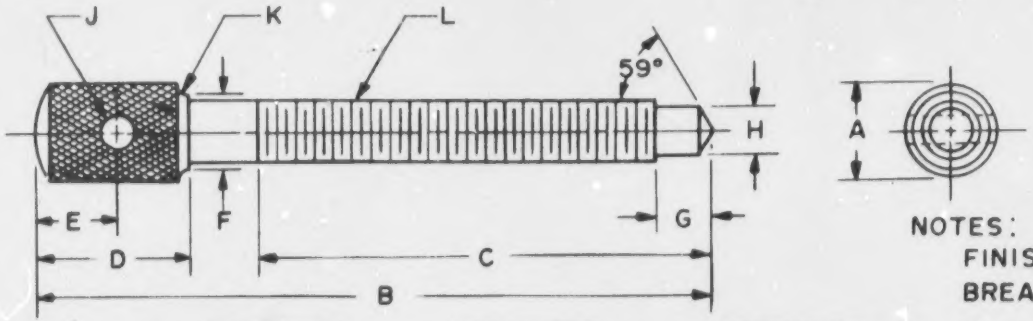


NOTES: BREAK ALL SHARP EDGES.
MATERIAL: CRS

REF. NO.	FINISHED DIMENSIONS (INCHES)								
	A	B	C	D	E	F	G	H	J
1	3/4	5/16	5/32	1/2	1/16	7/32	.149 DIA.	7R/64	1R/32
2	1	3/8	3/16	3/4	1/16	9/32	.149 DIA.	9R/64	1R/32
3	1 1/8	1/2	1/4	3/4	1/8	11/32	.177 DIA.	11R/64	1R/16
4	1 3/8	5/8	5/16	1	1/8	13/32	.177 DIA.	13R/64	1R/16
5	1 3/8	3/4	3/8	1	1/8	17/32	.177 DIA.	17R/64	1R/16

TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
±.003 DECIMAL
± 1/64 FRACTIONAL

DRAWN BY: V.C.L.	PARALLEL CLAMP STRAIGHT CLIP	DWG. NO. 59



ALTERNATE DESIGNS FOR KNURLED END

NOTES:
FINISH ALL OVER.
BREAK SHARP EDGES.

TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
FRACTIONAL $\pm \frac{1}{64}$
DECIMAL $\pm .003$

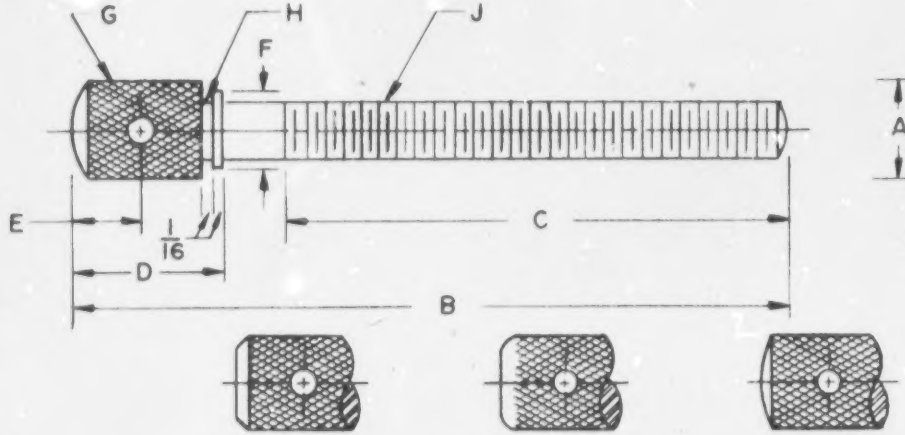
REF. NO.	FINISHED DIMENSIONS (INCHES)											
	A	B	C	D	E	F	G	H	J	K	L	JAW OPENING
1	$\frac{5}{16}$	$2\frac{3}{32}$	$1\frac{1}{4}$	$\frac{5}{8}$	$\frac{5}{16}$	$\frac{1}{4}$	$\frac{5}{32}$	.120	$\frac{1}{8}$	$\frac{1}{32}$ R	10-24UNC-2	1
2	$\frac{3}{8}$	$2\frac{13}{16}$	$1\frac{13}{16}$	$\frac{3}{4}$	$\frac{3}{8}$	$\frac{5}{16}$	$\frac{7}{32}$	.180	$\frac{1}{8}$	$\frac{1}{32}$ R	$\frac{1}{2}$-20UNC-2	$1\frac{1}{2}$
3	$\frac{1}{2}$	$3\frac{5}{8}$	$2\frac{3}{8}$	$\frac{7}{8}$	$\frac{7}{16}$	$\frac{3}{8}$	$\frac{9}{32}$	.240	$\frac{3}{16}$	$\frac{1}{16}$ R	$\frac{5}{16}$-18UNC-2	2
4	$\frac{5}{8}$	$4\frac{7}{16}$	$2\frac{15}{16}$	1	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{11}{32}$	.300	$\frac{3}{16}$	$\frac{1}{16}$ R	$\frac{3}{8}$-16UNC-2	$2\frac{1}{2}$
5	$\frac{3}{4}$	$5\frac{3}{4}$	4	$1\frac{1}{8}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{13}{16}$	.360	$\frac{1}{4}$	$\frac{1}{16}$ R	$\frac{1}{2}$-13UNC-2	$3\frac{1}{2}$

MATERIAL: C R S CASE HARDEN

DRAWN BY: V.C.L.

PARALLEL CLAMP CLAMPING SCREW

DWG. NO. 60



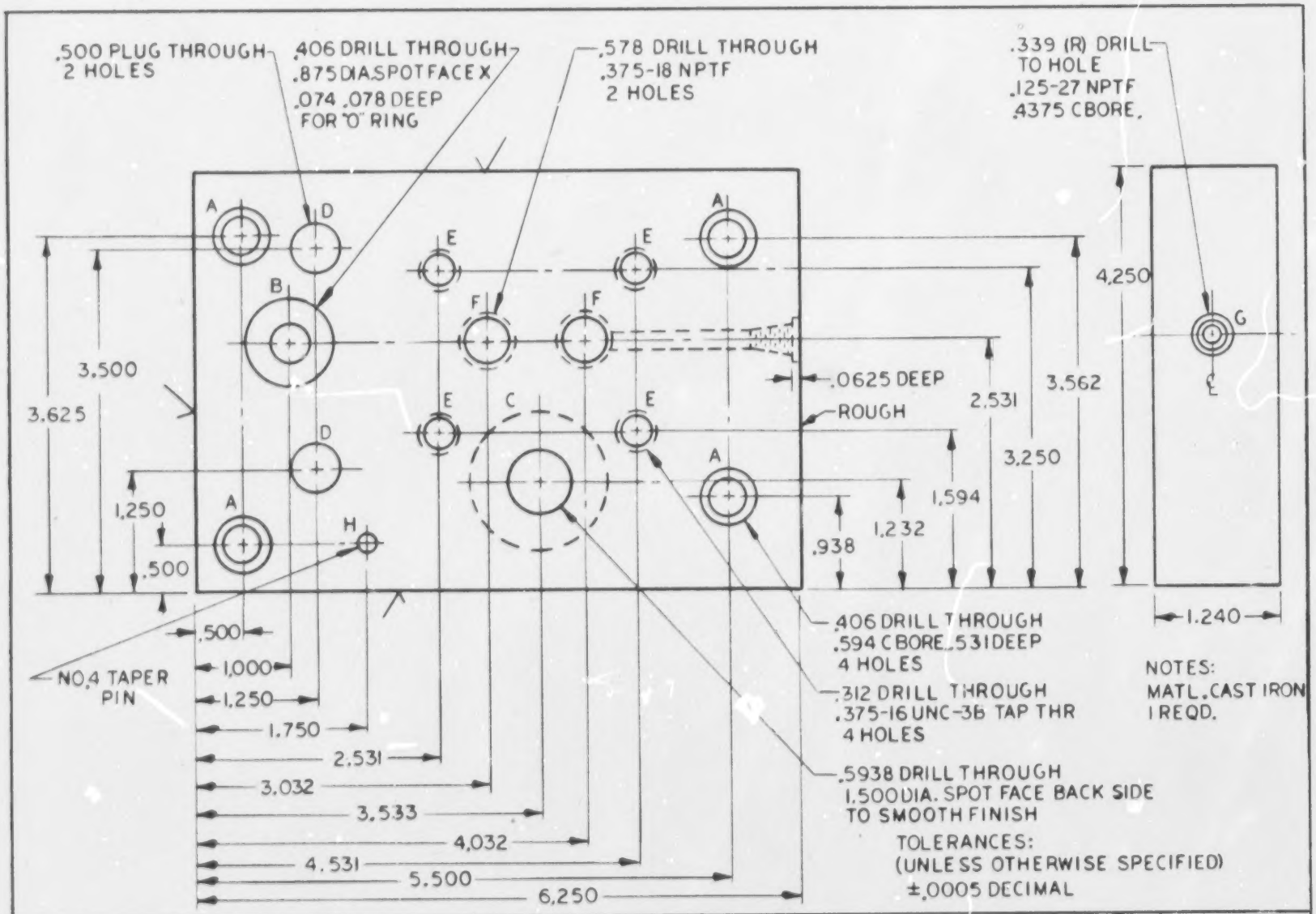
ALTERNATE DESIGNS FOR KNURLED END

NOTES:
FINISH ALL OVER.
BREAK SHARP EDGES.
TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
FRACTIONAL $\pm \frac{1}{64}$

REF. NO.	FINISHED DIMENSIONS (INCHES)									
	A	B	C	D	E	F	G	H	J	JAW OPENING
1	$\frac{5}{16}$	$2\frac{1}{4}$	$1\frac{3}{8}$	$\frac{5}{8}$	$\frac{1}{4}$	$\frac{7}{32}$	$\frac{1}{8}$	$\frac{3}{16}$ DIA.	10-24UNC-2	1
2	$\frac{3}{8}$	3	2	$\frac{3}{4}$	$\frac{5}{16}$	$\frac{9}{32}$	$\frac{1}{8}$	$\frac{1}{4}$ DIA.	$\frac{1}{4}$-20UNC-2	$1\frac{1}{2}$
3	$\frac{1}{2}$	$3\frac{7}{8}$	$2\frac{5}{8}$	$\frac{7}{8}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{16}$	$\frac{5}{16}$ DIA.	$\frac{5}{16}$-18UNC-2	2
4	$\frac{5}{8}$	$4\frac{3}{4}$	$3\frac{1}{4}$	1	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{3}{16}$	$\frac{3}{8}$ DIA.	$\frac{3}{8}$-16UNC-2	$2\frac{1}{2}$
5	$\frac{3}{4}$	$6\frac{1}{8}$	$4\frac{3}{8}$	$1\frac{1}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{1}{4}$	$\frac{1}{2}$ DIA.	$\frac{1}{2}$-13UNC-2	$3\frac{1}{2}$

MATERIAL: C R S
CASE HARDEN

DRAWN BY: V.C.L.	PARALLEL CLAMP ADJUSTING SCREW	DWG. NO. 61


.500 PLUG THROUGH
2 HOLES
.406 DRILL THROUGH
.875 DIA SPOTFACE X
.074 .078 DEEP
FOR "O" RING
.578 DRILL THROUGH
.375-18 NPTF
2 HOLES
.339 (R) DRILL
TO HOLE
.125-27 NPTF
.4375 CBORE.
A
D
B
E
F
C
G
H
3.500
3.625
1.250
.500
.0625 DEEP
ROUGH
2.531
3.562
3.250
1.594
1.232
.938
4.250
1.240
.500
1.000
1.250
1.750
2.531
3.032
3.533
4.032
4.531
5.500
6.250
NO.4 TAPER
PIN
.406 DRILL THROUGH
.594 CBORE .531 DEEP
4 HOLES
.312 DRILL THROUGH
.375-16 UNC-3B TAP THR
4 HOLES
.5938 DRILL THROUGH
1.500 DIA. SPOT FACE BACK SIDE
TO SMOOTH FINISH
TOLERANCES:
(UNLESS OTHERWISE SPECIFIED)
±.0005 DECIMAL
NOTES:
MATL. CAST IRON
1 REQD.
DRAWN BY: E.F.S.
SCALE: ——
MOTOR PLATE
DWG. NO. 72